JOHNSON'S HANDY MANUAL

ON

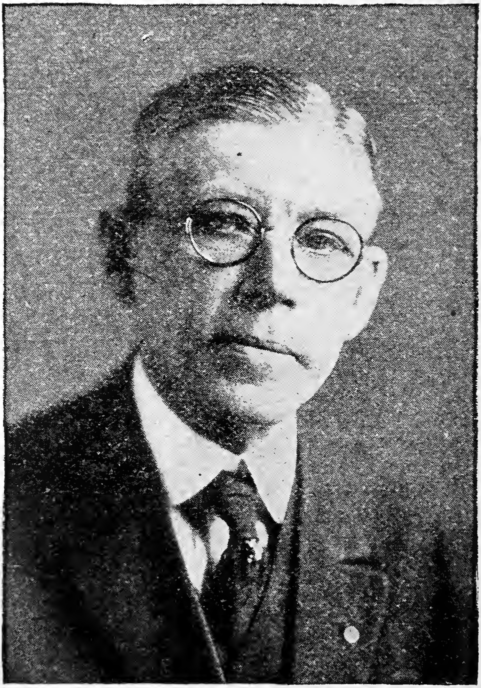
PLUMBING

Special Notice

THIS edition of *Johnson's Handy Manual* contains a supplement filled with right-up-to-the-minute stuff, following the general index.

It's good stuff and I know you will like it.

J. W. J.



JOHN W. JOHNSON,

Author and Publisher of "Johnson's Handy Manual" and Mechanical Engineer

JOHNSON'S NEW HANDY MANUAL

ON

PLUMBING

DOMESTIC AND SANITARY ENGINEERING, DRAINAGE AND SEWERAGE

ELEVENTH EDITION

PRICE by Parcel Post $1.50 Net
Canada and Foreign Countries $2.00

JOHN W. JOHNSON

PARK RIDGE, ILL.
U. S. A.

Dedication

TO THE STEAM-FITTERS AND PLUMBERS

WITH WHOM I HAVE SPENT
SO MANY PLEASANT YEARS,
I DEDICATE THIS MANUAL

INTRODUCTION

IN presenting this book to the Profession and Trade I wish to call attention to the many illustrations which have been clearly and accurately reproduced in detail and still retaining the handy pocket size of the Manual. Also to the questions and answers for Master and Journeymen Plumbers gleaned from far and near.

The information contained herein is thoroughly practical and based on the experience of hundreds of the best known Plumbers, Inspectors, and from City and State codes throughout the country, chief among them being the Wisconsin State Code, by courtesy of the Chief Plumbing Inspector.

My endeavor has been to assemble only such information on every detail of the plumbing business as will meet the exacting requirements of the times, in an effort to maintain the present high standards of the Plumbing Profession.

JOHN W. JOHNSON,
Author.

An Easy and Correct Method of Ascertaining Length of Pipe Required in 45° Angles

In the pipe fitting of steam and hot water heating plants, 45 degree elbows are brought into use extensively and it is not every mechanic who has mastered mathematics sufficiently to be able to figure square root in order to find the hypotenuse of an angle, and on this account we give the following methods of getting the measurements of 45 degree angles, which is approximately correct for pipe use.

For each inch of offset add $^{53}/_{128}$ of an inch and the result will be the distance from center to center of the 45 degree angle.

For instance: Referring to illustration, Fig 4, we will suppose that a pipe is to be brought up from a lower floor near a wall, and it is to pass through the ceiling of a room at a distance of 20 inches farther away from the wall than that which it rises through the floor, as indicated in the illustration by the figures, 20 inches, which is shown by the plumb-bob. This shows that the distance in a straight line from center to center of the two points is 20 inches. Now it is simply necessary to add to the 20 inches 20 times 53, and divide the result by 128, to get the additional length necessary for the 45 degree angle. Thus:—$20 \times 53 = 1060$, $1060 \div 128 = 8^9/_{32}$, which added to the 20 inches, makes the distance of the angle, as shown, $28^9/_{32}$ inch.

In any case it will be necessary to allow for the distance taken up by the fittings from center to center of same, as shown in Fig. 5.

By this system it will make no difference how many inches the offset may be; simply add for each inch an additional fraction of $^{53}/_{128}$ of an inch. Again, suppose the offset is to be 5 inches, we multiply 5

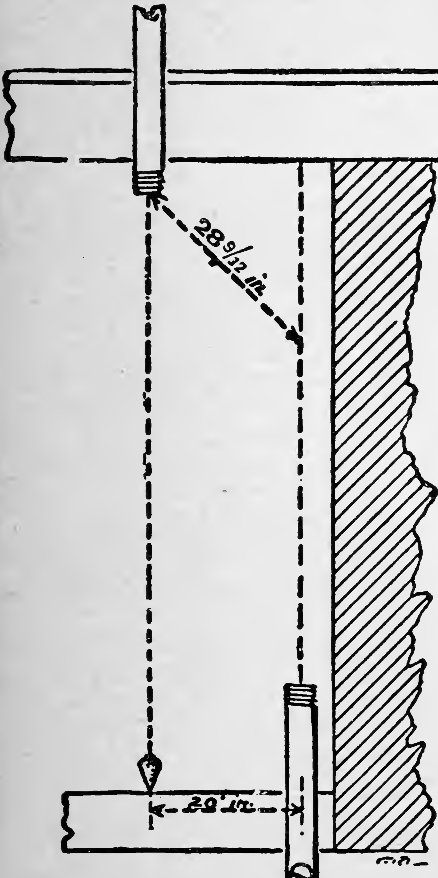


Fig. 4

by 53, which gives us 265. We now divide the 265 by 128, which gives us $2^1/_{16}$; this result we now add to 5 inches, which is the distance of offset, and we have $7^1/_{16}$ inches from center to center of the 45 degree angle. Any distance may be obtained in the same manner.

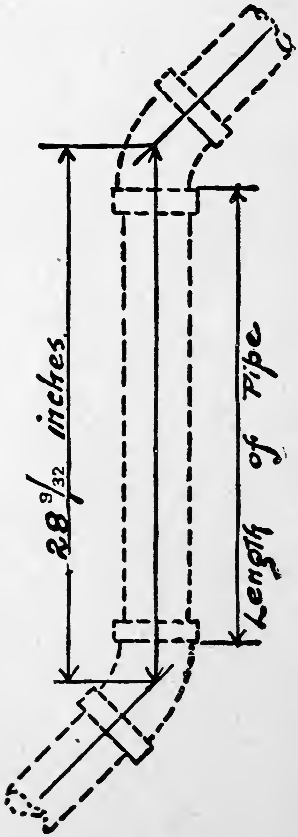


Fig. 5

Table of Diagonals for 45° Triangles Measuring from 1 Inch to 20 Feet on the Sides.

Sides. Ft.	Sides. In.	Diagonal. Ft.	Diagonal. In.	Sides. Ft.	Sides. In.	Diagonal. Ft.	Diagonal. In.
	1		1 7/16	3	1	4	4 5/16
	2		2 13/16	3	2	4	5 3/4
	3		4 1/4	3	3	4	7 3/16
	4		5 5/8	3	4	4	8 9/16
	5		7 1/16	3	5	4	10
	6		8 1/2	3	6	4	11 3/8
	7		9 7/8	3	7	5	13/16
	8		11 5/16	3	8	5	2 1/4
	9		12 3/4	3	9	5	3 5/8
	10	1	2 1/8	3	10	5	5 1/16
	11	1	3 9/16	3	11	5	6 7/16
	12	1	5	4		5	7 7/8
1	1	1	6 3/8	4	1	5	9 5/16
1	2	1	7 13/16	4	2	5	10 11/16
1	3	1	9 3/16	4	3	6	1/8
1	4	1	10 5/8	4	4	6	1 9/16
1	5	2	1/16	4	5	6	2 15/16
1	6	2	1 7/16	4	6	6	4 3/8
1	7	2	2 7/8	4	7	6	5 3/4
1	8	2	4 5/16	4	8	6	7 3/16
1	9	2	5 11/16	4	9	6	8 5/8
1	10	2	7 1/8	4	10	6	10
1	11	2	8 1/2	4	11	6	11 7/16
2		2	9 15/16	5		7	7/8
2	1	2	11 3/8	5	1	7	2 1/4
2	2	3	3/4	5	2	7	3 11/16
2	3	3	2 3/16	5	3	7	5 1/16
2	4	3	3 5/16	5	4	7	6 1/2
2	5	3	5	5	5	7	7 15/16
2	6	3	6 7/16	5	6	7	9 5/16
2	7	3	7 13/16	5	7	7	10 3/4
2	8	3	9 1/4	5	8	8	3/16
2	9	3	10 11/16	5	9	8	1 9/16
2	10	4	1/16	5	10	8	3
2	11	4	1 1/2	5	11	8	4 7/16
3		4	2 15/16	6		8	5 13/16

Extreme caution must be exercised in taking off centers of fittings in these measurements.

Table of Diagonals for 45° Triangles Measuring from 1 Inch to 20 Feet on the Sides.

Sides. Ft.	In.	Diagonal. Ft.	In.	Sides. Ft.	In.	Diagonal. Ft.	In.
6	1	8	7¼	9	1	12	10⅛
6	2	8	8⅝	9	2	12	11 9/16
6	3	8	10 1/16	9	3	13	1
6	4	8	11½	9	4	13	2⅜
6	5	9	⅞	9	5	13	3 13/16
6	6	9	2 5/16	9	6	13	5¼
6	7	9	3¾	9	7	13	6⅝
6	8	9	5⅛	9	8	13	8 1/16
6	9	9	6½	9	9	13	9 7/16
6	10	9	7 15/16	9	10	13	10⅞
6	11	9	9⅜	9	11	14	5/16
7		9	10 13/16	10		14	1 11/16
7	1	10	3/16	10	1	14	3⅛
7	2	10	1⅝	10	2	14	4 9/16
7	3	10	3	10	3	14	5 15/16
7	4	10	4 7/16	10	4	14	7⅜
7	5	10	5⅞	10	5	14	8¾
7	6	10	7¼	10	6	14	10 3/16
7	7	10	8 11/16	10	7	14	11⅝
7	8	10	10⅛	10	8	15	1
7	9	10	11½	10	9	15	2 7/16
7	10	11	15/16	10	10	15	3⅞
7	11	11	2⅜	10	11	15	5¼
8		11	3¾	11		15	6 11/16
8	1	11	5 3/16	11	1	15	8 1/16
8	2	11	6⅝	11	2	15	9½
8	3	11	8	11	3	15	10 15/16
8	4	11	9 7/16	11	4	16	⅜
8	5	11	10 13/16	11	5	16	1¾
8	6	12	¼	11	6	16	3 3/16
8	7	12	1 11/16	11	7	16	4 9/16
8	8	12	3 1/16	11	8	16	6
8	9	12	4½	11	9	16	7⅜
8	10	12	5⅞	11	10	16	8 13/16
8	11	12	7 5/16	11	11	16	10¼
9		12	8¾	12		16	11⅝

Extreme caution must be exercised in taking off centers of fittings in these measurements.

Table of Diagonals for 45° Triangles Measuring from 1 Inch to 20 Feet on the Sides.

Sides. Ft.	In.	Diagonal. Ft.	In.	Sides. Ft.	In.	Diagonal. Ft.	In.
18	1	25	6⅞	19	1	26	11⅞
18	2	25	8 5/16	19	2	27	1¼
18	3	25	9 11/16	19	3	27	2 11/16
18	4	25	11⅛	19	4	27	4 1/16
18	5	26	9/16	19	5	27	5½
18	6	26	1 15/16	19	6	27	6 15/16
18	7	26	3⅜	19	7	27	8 5/16
18	8	26	4 13/16	19	8	27	9¾
18	9	26	6 3/16	19	9	27	11 3/16
18	10	26	7⅝	19	10	28	9/16
18	11	26	9	19	11	28	2
19		26	10 7/16	20		28	3 7/16

Extreme caution must be exercised in taking off centers of fittings in these measurements.

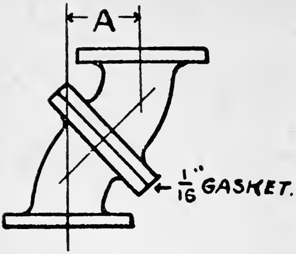
Table of Diagonals for 45° Triangles Measuring from 1 Inch to 20 Feet on the Sides.

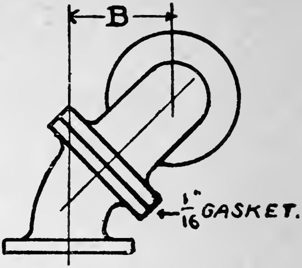
Sides. Ft.	In.	Diagonal. Ft.	In.	Sides. Ft.	In.	Diagonal. Ft.	In.
12	1	17	1 1/16	15	1	21	4
12	2	17	2 7/16	15	2	21	5 3/8
12	3	17	3 7/8	15	3	21	6 13/16
12	4	17	5 5/16	15	4	21	8 3/16
12	5	17	6 11/16	15	5	21	9 5/8
12	6	17	8 1/8	15	6	21	11 1/16
12	7	17	9 9/16	15	7	22	7/16
12	8	17	10 15/16	15	8	22	1 7/8
12	9	18	3/8	15	9	22	3 5/16
12	10	18	11 13/16	15	10	22	4 11/16
12	11	18	3 3/16	15	11	22	6 1/8
3		18	4 5/8	16		22	7 1/2
13	1	18	6	16	1	22	8 15/16
13	2	18	7 7/16	16	2	22	10 3/8
13	3	18	8 7/8	16	3	22	11 3/4
13	4	18	10 1/4	16	4	23	1 3/16
13	5	18	1 11/16	16	5	23	2 5/8
13	6	19	1 1/8	16	6	23	4
13	7	19	2 1/2	16	7	23	5 7/16
13	8	19	3 15/16	16	8	23	6 13/16
13	9	19	5 5/16	16	9	23	8 1/4
13	10	19	6 3/4	16	10	23	9 11/16
13	11	19	8 3/16	16	11	23	11 1/16
14		19	9 9/16	17		24	1/2
14	1	19	11	17	1	24	1 15/16
14	2	20	7/16	17	2	24	3 5/16
14	3	20	1 13/16	17	3	24	4 3/4
14	4	20	3 1/4	17	4	24	6 1/8
14	5	20	4 11/16	17	5	24	7 9/16
14	6	20	6 1/16	17	6	24	9
14	7	20	7 1/2	17	7	24	10 3/8
14	8	20	8 7/8	17	8	24	11 13/16
14	9	20	10 5/16	17	9	25	1 1/4
14	10	20	11 3/4	17	10	25	2 5/8
14	11	21	1 1/8	17	11	25	4 1/16
15		21	2 9/16	18		25	5 1/2

Extreme caution must be exercised in taking off centers of fittings in these measurements.

OFFSETS

STANDARD FLGD. ELLS.





45° ELLS

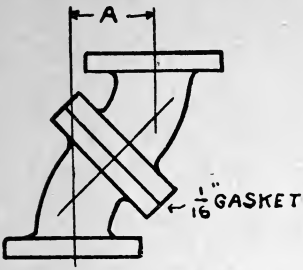
SIZE	OFFSET A
2	3 $\frac{9}{16}$
2 $\frac{1}{2}$	4 $\frac{1}{4}$
3	4 $\frac{1}{4}$
3 $\frac{1}{2}$	5
4	5 $\frac{11}{16}$
4 $\frac{1}{2}$	5 $\frac{11}{16}$
5	6 $\frac{3}{8}$
6	7 $\frac{1}{8}$
7	7 $\frac{13}{16}$
8	7 $\frac{13}{16}$
9	8 $\frac{1}{2}$
10	9 $\frac{1}{4}$
12	10 $\frac{5}{8}$
14	10 $\frac{5}{8}$
15	11 $\frac{3}{8}$
16	11 $\frac{3}{8}$
18	12 $\frac{1}{16}$
20	13 $\frac{1}{2}$
22	14 $\frac{3}{16}$
24	15 $\frac{5}{8}$

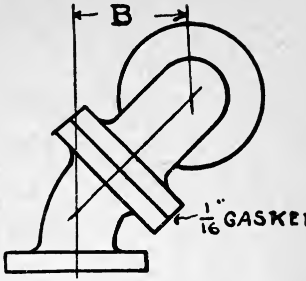
45° AND 90° ELLS.

SIZE	OFFSET B
2	5
2 $\frac{1}{2}$	5 $\frac{11}{16}$
3	6 $\frac{1}{16}$
3 $\frac{1}{2}$	6 $\frac{3}{4}$
4	7 $\frac{7}{16}$
4 $\frac{1}{2}$	7 $\frac{13}{16}$
5	8 $\frac{1}{2}$
6	9 $\frac{1}{4}$
7	9 $\frac{15}{16}$
8	10 $\frac{5}{16}$
9	11 $\frac{3}{8}$
10	12 $\frac{7}{16}$
12	13 $\frac{13}{16}$
14	15 $\frac{1}{4}$
15	15 $\frac{15}{16}$
16	16 $\frac{5}{16}$
18	17 $\frac{11}{16}$
20	19 $\frac{1}{2}$
22	21 $\frac{1}{4}$
24	23 $\frac{3}{8}$

OFFSETS.

EXTRA HEAVY FLGD. ELLS.





45° ELLS

SIZE	OFFSET A
2	$4\frac{1}{4}$
$2\frac{1}{2}$	5
3	5
$3\frac{1}{2}$	$5\frac{11}{16}$
4	$6\frac{3}{8}$
$4\frac{1}{2}$	$6\frac{3}{8}$
5	$7\frac{1}{8}$
6	$7\frac{13}{16}$
7	$8\frac{1}{2}$
8	$8\frac{1}{2}$
9	$9\frac{1}{4}$
10	$9\frac{15}{16}$
12	$11\frac{3}{8}$
14	$11\frac{3}{8}$
15	$12\frac{1}{16}$
16	$12\frac{3}{4}$
18	$13\frac{1}{2}$
20	$14\frac{3}{16}$
22	$14\frac{7}{8}$
24	$16\frac{5}{16}$

45° AND 90° ELLS

SIZE	OFFSET B
2	$5\frac{11}{16}$
$2\frac{1}{2}$	$6\frac{3}{8}$
3	$6\frac{3}{4}$
$3\frac{1}{2}$	$7\frac{7}{16}$
4	$8\frac{3}{16}$
$4\frac{1}{2}$	$8\frac{1}{2}$
5	$9\frac{1}{4}$
6	$9\frac{15}{16}$
7	$10\frac{5}{8}$
8	$11\frac{3}{8}$
9	$12\frac{1}{16}$
10	$13\frac{1}{8}$
12	$14\frac{7}{8}$
14	$15\frac{15}{16}$
15	$16\frac{3}{8}$
16	$17\frac{11}{16}$
18	$18\frac{3}{4}$
20	$20\frac{3}{16}$
22	$21\frac{5}{8}$
24	$23\frac{3}{4}$

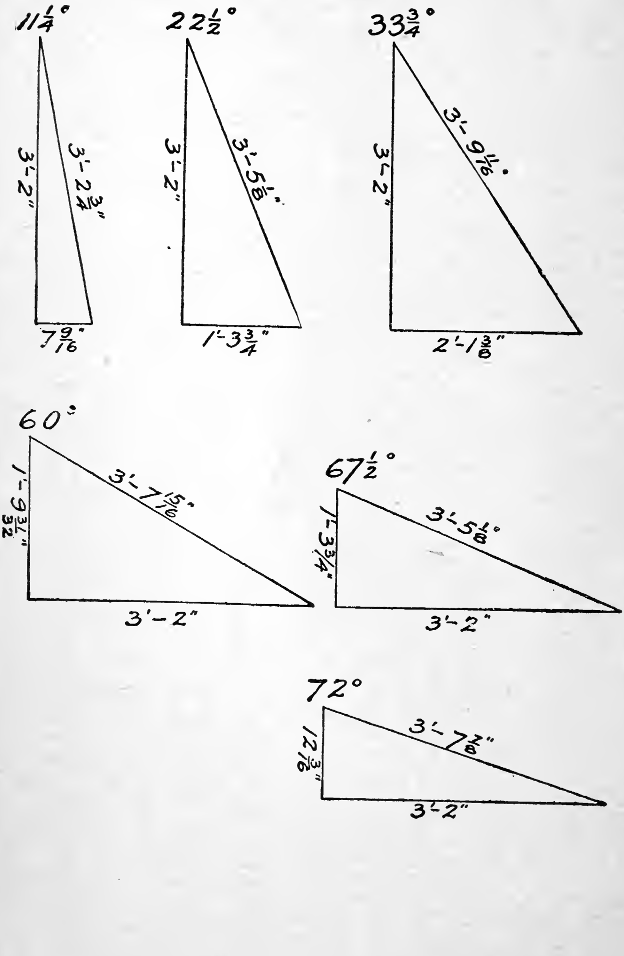

11¼°
3'-2"
3'-2¾"
7 9/16"
22½°
3'-2"
3'-5⅛"
1'-3¾"
33¾°
3'-2"
3'-9 11/16"
2'-1⅜"
60°
1'-9 31/32"
3'-7 15/16"
3'-2"
67½°
1'-3¾"
3'-5⅛"
3'-2"
72°
12 3/16"
3'-7⅞"
3'-2"

Table of Diagonals for 11¼° Triangles Measuring from 1 Inch to 10 Feet on the Sides.

Long Leg Ft.	Long Leg In.	Sh. Leg Ft.	Sh. Leg In.	Diag. Ft.	Diag. In.	Long Leg Ft.	Long Leg In.	Sh. Leg Ft.	Sh. Leg In.	Diag. Ft.	Diag. In.
	1		3/16		1	3	0		7 3/16	3	11/16
	2		3/8		2 1/16	3	1		7 3/8	3	1 11/16
	3		5/8		3 1/16	3	2		7 9/16	3	2 3/4
	4		13/16		4 1/16	3	3		7 13/16	3	3 3/4
	5		1		5 1/8	3	4		8	3	4 3/4
	6		1 3/16		6 1/8	3	5		8 3/16	3	5 13/16
	7		1 3/8		7 1/8	3	6		8 3/8	3	6 13/16
	8		1 9/16		8 1/8	3	7		8 9/16	3	7 13/16
	9		1 13/16		9 3/16	3	8		8 3/4	3	8 13/16
	10		2		10 3/16	3	9		9	3	9 7/8
	11		2 3/16		11 3/16	3	10		9 3/16	3	10 7/8
1	0		2 3/8	1	1/4	3	11		9 3/8	3	11 7/8
1	1		2 9/16	1	1 1/4	4	0		9 9/16	4	15/16
1	2		2 3/4	1	2 5/16	4	1		9 3/4	4	1 15/16
1	3		3	1	3 5/16	4	2		9 15/16	4	3
1	4		3 3/16	1	4 5/16	4	3		10 3/16	4	4
1	5		3 3/8	1	5 3/8	4	4		10 3/8	4	5
1	6		3 9/16	1	6 3/8	4	5		10 9/16	4	6 1/16
1	7		3 3/4	1	7 3/8	4	6		10 3/4	4	7 1/16
1	8		3 15/16	1	8 3/8	4	7		10 15/16	4	8 1/16
1	9		4 3/16	1	9 7/16	4	8		11 1/8	4	9 1/16
1	10		4 3/8	1	10 7/16	4	9		11 3/8	4	10 1/8
1	11		4 9/16	1	11 7/16	4	10		11 5/8	4	11 1/8
2	0		4 3/4	2	1/2	4	11		11 13/16	5	1/8
2	1		4 15/16	2	1 1/2	5	0	1	0	5	1 3/16
2	2		5 1/8	2	2 9/16	5	1	1	3/16	5	2 3/16
2	3		5 3/8	2	3 9/16	5	2	1	3/8	5	3 1/4
2	4		5 9/16	2	4 9/16	5	3	1	5/8	5	4 1/4
2	5		5 3/4	2	5 5/8	5	4	1	13/16	5	5 1/4
2	6		5 15/16	2	6 5/8	5	5	1	1	5	6 5/16
2	7		6 1/8	2	7 5/8	5	6	1	1 3/16	5	7 5/16
2	8		6 5/16	2	8 5/8	5	7	1	1 3/8	5	8 5/16
2	9		6 9/16	2	9 11/16	5	8	1	1 9/16	5	9 5/16
2	10		6 3/4	2	10 11/16	5	9	1	1 3/4	5	10 3/8
2	11		6 15/16	2	11 11/16	5	10	1	1 15/16	5	11 3/8

Extreme caution must be exercised in taking off centers of fittings in these measurements.

Table of Diagonals for 11¼° Triangles Measuring from 1 Inch to 10 Feet on the Sides.

Long Leg Ft.	Long Leg In.	Sh. Leg Ft.	Sh. Leg In.	Diag. Ft.	Diag. In.	Long Leg Ft.	Long Leg In.	Sh. Leg Ft.	Sh. Leg In.	Diag. Ft.	Diag. In.
5	11	1	2⅛	6	⅜	8	0	1	7 1/16	8	1⅞
6	0	1	2 5/16	6	1 7/16	8	1	1	7¼	8	2⅞
6	1	1	2½	6	2 7/16	8	2	1	7 7/16	8	3 15/16
6	2	1	2 11/16	6	3½	8	3	1	7 11/16	8	4 15/16
6	3	1	2 15/16	6	4½	8	4	1	7⅞	8	5 15/16
6	4	1	2⅛	6	5½	8	5	1	8 1/16	8	7
6	5	1	3 5/16	6	6½	8	6	1	8¼	8	8
6	6	1	3½	6	7½	8	7	1	8 7/16	8	9
6	7	1	3 11/16	6	8½	8	8	1	8⅝	8	10
6	8	1	3⅞	6	9½	8	9	1	8⅞	8	11 1/16
6	9	1	4⅛	6	10⅝	8	10	1	9 1/16	9	1/16
6	10	1	4 5/16	6	11⅝	8	11	1	9¼	9	1 1/16
6	11	1	4½	7	⅝	9	0	1	9½	9	2⅛
7	0	1	4 11/16	7	1⅝	9	1	1	9 11/16	9	3⅛
7	1	1	4⅞	7	2⅝	9	2	1	9⅞	9	4⅛
7	2	1	5 1/16	7	3 11/16	9	3	1	10⅛	9	5 3/16
7	3	1	5 5/16	7	4 11/16	9	4	1	10 5/16	9	6 3/16
7	4	1	5½	7	5 11/16	9	5	1	10½	9	7 3/16
7	5	1	5 11/16	7	6¾	9	6	1	10 11/16	9	8¼
7	6	1	5⅞	7	7¾	9	7	1	10⅞	9	9¼
7	7	1	6 1/16	7	8¾	9	8	1	11 1/16	9	10¼
7	8	1	6¼	7	9¾	9	9	1	11¼	9	11 5/16
7	9	1	6½	7	10 13/16	9	10	1	11 7/16	10	5/16
7	10	1	6 11/16	7	11 13/16	9	11	1	11⅝	10	1 5/16
7	11	1	6⅞	8	13/16	10	0	1	11 13/16	10	2⅜

Extreme caution must be exercised in taking off centers of fittings in these measurements.

Table of Diagonals for 22½° Triangles Measuring from 1 Inch to 10 Feet on the Sides.

Long Leg Ft.	Long Leg In.	Short Leg Ft.	Short Leg In.	Diagonal Ft.	Diagonal In.	Long Leg Ft.	Long Leg In.	Short Leg Ft.	Short Leg In.	Diagonal Ft.	Diagonal In.
	1		7/16		1 1/16	3	1	1	3 5/16	3	4 1/16
	2		13/16		2 3/16	3	2	1	3 3/4	3	5 1/8
	3		1 1/4		3 1/4	3	3	1	4 1/8	3	6 3/16
	4		1 11/16		4 5/16	3	4	1	4 9/16	3	7 5/16
	5		2 1/16		5 7/16	3	5	1	5	3	8 3/8
	6		2 1/2		6 1/2	3	6	1	5 3/8	3	9 7/16
	7		2 7/8		7 9/16	3	7	1	5 13/16	3	10 9/16
	8		3 5/16		8 11/16	3	8	1	6 1/4	3	11 5/8
	9		3 3/4		9 3/4	3	9	1	6 5/8	4	11/16
	10		4 1/8		10 13/16	3	10	1	7 1/16	4	1 13/16
	11		4 9/16		11 7/8	3	11	1	7 7/16	4	2 7/8
1	0		5	1	1	4	0	1	7 7/8	4	3 15/16
1	1		5 3/8	1	2 1/16	4	1	1	8 5/16	4	5 1/16
1	2		5 13/16	1	3 1/8	4	2	1	8 11/16	4	6 1/8
1	3		6 1/4	1	4 1/4	4	3	1	9 1/8	4	7 3/16
1	4		6 11/16	1	5 5/16	4	4	1	9 9/16	4	8 5/16
1	5		7 1/16	1	6 3/8	4	5	1	9 15/16	4	9 3/8
1	6		7 1/2	1	7 1/2	4	6	1	10 3/8	4	10 7/16
1	7		7 7/8	1	8 9/16	4	7	1	10 3/4	4	11 1/2
1	8		8 5/16	1	9 5/8	4	8	1	11 3/16	5	5/8
1	9		8 3/4	1	10 3/4	4	9	1	11 5/8	5	1 11/16
1	10		9 1/8	1	11 13/16	4	10	2	0	5	2 3/4
1	11		9 9/16	2	7/8	4	11	2	7/16	5	3 7/8
2	0		9 15/16	2	2	5	0	2	7/8	5	4 15/16
2	1		10 3/8	2	3 1/16	5	1	2	1 1/4	5	6
2	2		10 3/4	2	4 1/8	5	2	2	1 11/16	5	7 1/8
2	3		11 3/16	2	5 1/4	5	3	2	2 1/8	5	8 3/16
2	4		11 5/8	2	6 5/16	5	4	2	2 1/2	5	9 1/4
2	5	1	0	2	7 3/8	5	5	2	2 15/16	5	10 3/8
2	6	1	7/16	2	8 1/2	5	6	2	3 5/16	5	11 7/16
2	7	1	1 3/16	2	9 9/16	5	7	2	3 3/4	6	1/2
2	8	1	1 1/4	2	10 5/8	5	8	2	4 3/16	6	1 5/8
2	9	1	1 11/16	2	11 11/16	5	9	2	4 9/16	6	2 11/16
2	10	1	2 1/16	3	13/16	5	10	2	5	6	3 3/4
2	11	1	2 1/2	3	1 7/8	5	11	2	5 3/8	6	4 7/8
3	0	1	2 15/16	3	2 15/16	6	0	2	5 13/16	6	5 15/16

Extreme caution must be exercised in taking off centers of fittings in these measurements.

Table of Diagonals for 22½° Triangles Measuring from 1 Inch to 10 Feet on the Sides.

Long Leg		Short Leg.		Diagonal.		Long Leg		Short Leg.		Diagonal.	
Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.
6	1	2	6 1/4	6	7	8	1	3	4 3/16	8	9
6	2	2	6 5/8	6	8 1/8	8	2	3	4 9/16	8	10 1/16
6	3	2	7 1/16	6	9 3/16	8	3	3	5	8	11 1/8
6	4	2	7 1/2	6	10 1/4	8	4	3	5 7/16	9	1/4
6	5	2	7 7/8	6	11 3/8	8	5	3	5 13/16	9	1 5/16
6	6	2	8 5/16	7	7/16	8	6	3	6 1/4	9	2 3/8
6	7	2	8 3/4	7	1 1/2	8	7	3	6 11/16	9	3 1/2
6	8	2	9 1/8	7	2 5/8	8	8	3	7 1/16	9	4 9/16
6	9	2	9 9/16	7	3 11/16	8	9	3	7 1/2	9	5 5/8
6	10	2	9 15/16	7	4 3/4	8	10	3	7 7/8	9	6 3/4
6	11	2	10 3/8	7	5 13/16	8	11	3	8 5/16	9	7 13/16
7	0	2	10 13/16	7	6 15/16	9	0	3	8 3/4	9	8 7/8
7	1	2	11 3/16	7	8	9	1	3	9 1/8	9	10
7	2	2	11 5/8	7	9 1/16	9	2	3	9 9/16	9	11 1/16
7	3	3	1/16	7	10 3/16	9	3	3	10	10	1/8
7	4	3	7/16	7	11 1/4	9	4	3	10 3/8	10	1 1/4
7	5	3	7/8	8	5/16	9	5	3	10 13/16	10	2 5/16
7	6	3	1 1/4	8	1 7/16	9	6	3	11 1/4	10	3 3/8
7	7	3	1 11/16	8	2 1/2	9	7	3	11 5/8	10	4 1/2
7	8	3	2 1/8	8	3 9/16	9	8	4	1/16	10	5 9/16
7	9	3	2 1/2	8	4 11/16	9	9	4	7/16	10	6 5/8
7	10	3	2 15/16	8	5 3/4	9	10	4	7/8	10	7 3/4
7	11	3	3 3/8	8	6 13/16	9	11	4	1 5/16	10	8 13/16
8	0	3	3 3/4	8	7 15/16	10	0	4	1 11/16	10	9 7/8

Extreme caution must be exercised in taking off centers of fittings in these measurements.

Table of Diagonals of 33¾° Triangles Measuring from 1 Inch to 10 Feet on the Sides.

Long Leg Ft.	Long Leg In.	Short Leg Ft.	Short Leg In.	Diagonal Ft.	Diagonal In.	Long Leg Ft.	Long Leg In.	Short Leg Ft.	Short Leg In.	Diagonal Ft.	Diagonal In.
	1		11/16		1 3/16	3	1	2	3/4	3	8 1/2
	2		1 5/16		2 3/8	3	2	2	1 3/8	3	9 11/16
	3		2		3 5/8	3	3	2	2 1/16	3	10 7/8
	4		2 11/16		4 13/16	3	4	2	2 3/4	4	1/8
	5		3 5/16		6	3	5	2	3 3/8	4	1 5/16
	6		4		7 3/16	3	6	2	4 1/16	4	2 1/2
	7		4 11/16		8 7/16	3	7	2	4 3/4	4	3 11/16
	8		5 3/8		9 5/8	3	8	2	5 3/8	4	4 15/16
	9		6		10 13/16	3	9	2	6 1/16	4	6 1/8
	10		6 11/16	1	0	3	10	2	6 3/4	4	7 5/16
	11		7 3/8	1	1 1/4	3	11	2	7 3/8	4	8 1/2
1	0		8	1	2 7/16	4	0	2	8 1/16	4	9 3/4
1	1		8 11/16	1	3 5/8	4	1	2	8 3/4	4	10 15/16
1	2		9 3/8	1	4 13/16	4	2	2	9 3/8	5	1/8
1	3		10	1	6 1/16	4	3	2	10 1/16	5	1 5/16
1	4		10 11/16	1	7 1/2	4	4	2	10 3/4	5	2 9/16
1	5		11 3/8	1	8 7/16	4	5	2	11 7/16	5	3 3/4
1	6	1	0	1	9 5/8	4	6	3	1/16	5	4 15/16
1	7	1	11/16	1	10 7/8	4	7	3	3/4	5	6 1/8
1	8	1	1 3/8	2	1/16	4	8	3	1 7/16	5	7 3/8
1	9	1	2	2	1 1/4	4	9	3	2 1/16	5	8 9/16
1	10	1	2 11/16	2	2 7/16	4	10	3	2 3/4	5	9 3/4
1	11	1	3 3/8	2	3 11/16	4	11	3	3 7/16	5	10 15/16
2	0	1	4 1/16	2	4 7/8	5	0	3	4 1/16	6	3/16
2	1	1	4 11/16	2	6 1/16	5	1	3	4 3/4	6	1 3/8
2	2	1	5 3/8	2	7 1/4	5	2	3	5 7/16	6	2 9/16
2	3	1	6 1/16	2	8 1/2	5	3	3	6 1/8	6	3 3/4
2	4	1	6 11/16	2	9 11/16	5	4	3	6 3/4	6	5
2	5	1	7 3/8	2	10 7/8	5	5	3	7 7/16	6	6 3/16
2	6	1	8 1/16	3	1/16	5	6	3	8 1/8	6	7 3/8
2	7	1	8 11/16	3	1 1/8	5	7	3	8 3/4	6	8 9/16
2	8	1	9 3/8	3	2 1/2	5	8	3	9 7/16	6	9 13/16
2	9	1	10 1/16	3	3 11/16	5	9	3	10 1/8	6	11
2	10	1	10 11/16	3	4 7/8	5	10	3	10 3/4	7	3/16
2	11	1	11 3/8	3	6 1/8	5	11	3	11 7/16	7	1 3/8
3	0	2	1/16	3	7 5/16	6	0	4	1/8	7	2 5/8

Extreme caution must be exercised in taking off centers of fittings in these measurements.

Table of Diagonals of 33¾° Triangles Measuring from 1 Inch to 10 Feet on the Sides.

Long Leg Ft.	Long Leg In.	Short Leg. Ft.	Short Leg. In.	Diagonal Ft.	Diagonal In.	Long Leg Ft.	Long Leg In.	Short Leg. Ft.	Short Leg. In.	Diagonal Ft.	Diagonal In.
6	1	4	3/4	7	3 13/16	8	1	5	4 13/16	9	8 11/16
6	2	4	1 7/16	7	5	8	2	5	5 1/2	9	9 7/8
6	3	4	2 1/8	7	6 13/16	8	3	5	6 1/8	9	11 1/16
6	4	4	2 13/16	7	7 3/8	8	4	5	6 13/16	10	1/4
6	5	4	3 7/16	7	8 5/8	8	5	5	7 1/2	10	1 1/2
6	6	4	4 1/8	7	9 13/16	8	6	5	8 1/8	10	2 11/16
6	7	4	4 13/16	7	11	8	7	5	8 13/16	10	3 7/8
6	8	4	5 7/16	8	3/16	8	8	5	9 1/2	10	5 1/16
6	9	4	6 1/8	8	1 7/16	8	9	5	10 3/16	10	6 5/16
6	10	4	6 13/16	8	2 5/8	8	10	5	10 13/16	10	7 1/2
6	11	4	7 7/16	8	3 13/16	8	11	5	11 1/2	10	8 11/16
7	0	4	8 1/8	8	5	9	0	6	3/16	10	9 7/8
7	1	4	8 13/16	8	6 1/4	9	1	6	13/16	10	11 1/16
7	2	4	9 7/16	8	7 7/16	9	2	6	1 1/2	11	5/16
7	3	4	10 1/8	8	8 5/8	9	3	6	2 3/16	11	1 1/2
7	4	4	10 13/16	8	9 13/16	9	4	6	2 13/16	11	2 11/16
7	5	4	11 7/16	8	11 1/16	9	5	6	3 1/2	11	3 7/8
7	6	5	1/8	9	1/4	9	6	6	4 3/16	11	5 1/8
7	7	5	13/16	9	1 7/16	9	7	6	4 13/16	11	6 5/16
7	8	5	1 1/2	9	2 5/8	9	8	6	5 1/2	11	7 1/2
7	9	5	2 1/8	9	3 7/8	9	9	6	6 3/16	11	8 11/16
7	10	5	2 13/16	9	5 1/16	9	10	6	6 7/8	11	9 15/16
7	11	5	3 1/2	9	6 1/4	9	11	6	7 1/2	11	11 1/8
8	0	5	4 1/8	9	7 7/16	10	0	6	8 3/16	12	5/16

Extreme caution must be exercised in taking off centers of fittings in these measurements.

Table of Diagonals of 67 1/2° Triangles Measuring from 1 Inch to 10 Feet on the Sides.

Long Leg Ft	Long Leg In.	Short Leg Ft.	Short Leg In.	Diagonal. Ft.	Diagonal. In.	Long Leg Ft.	Long Leg In.	Short Leg. Ft.	Short Leg. In.	Diagonal Ft.	Diagonal In.
	1		7/16		1 1/16	3	1	1	3 5/16	3	4 1/16
	2		13/16		2 3/16	3	2	1	3 3/4	3	5 1/8
	3		1 1/4		3 1/4	3	3	1	4 1/8	3	6 3/16
	4		1 11/16		4 5/16	3	4	1	4 9/16	3	7 5/16
	5		2 1/16		5 7/16	3	5	1	5	3	8 3/8
	6		2 1/2		6 1/2	3	6	1	5 3/8	3	9 7/16
	7		2 7/8		7 9/16	3	7	1	5 13/16	3	10 9/16
	8		3 5/16		8 11/16	3	8	1	6 1/4	3	11 5/8
	9		3 3/4		9 3/4	3	9	1	6 5/8	4	11/16
	10		4 1/8		10 13/16	3	10	1	7 1/16	4	1 13/16
	11		4 9/16		11 7/8	3	11	1	7 7/16	4	2 7/8
1	0		5	1	1	4	0	1	7 7/8	4	3 15/16
1	1		5 3/8	1	2 1/16	4	1	1	8 5/16	4	5 1/16
1	2		5 13/16	1	3 1/8	4	2	1	8 11/16	4	6 1/8
1	3		6 1/4	1	4 1/4	4	3	1	9 1/8	4	7 3/16
1	4		6 11/16	1	5 5/16	4	4	1	9 9/16	4	8 5/16
1	5		7 1/16	1	6 3/8	4	5	1	9 15/16	4	9 3/8
1	6		7 1/2	1	7 1/2	4	6	1	10 3/8	4	10 7/16
1	7		7 7/8	1	8 9/16	4	7	1	10 3/4	4	11 1/2
1	8		8 5/16	1	9 5/8	4	8	1	11 3/16	5	5/8
1	9		8 3/4	1	10 3/4	4	9	1	11 5/8	5	1 11/16
1	10		9 1/8	1	11 13/16	4	10	2	0	5	2 3/4
1	11		9 9/16	2	7/8	4	11	2	7/16	5	3 7/8
2	0		9 15/16	2	2	5	0	2	7/8	5	4 15/16
2	1		10 3/8	2	3 1/16	5	1	2	1 1/4	5	6
2	2		10 3/4	2	4 1/8	5	2	2	1 11/16	5	7 1/8
2	3		11 3/16	2	5 1/4	5	3	2	2 1/8	5	8 3/16
2	4		11 5/8	2	6 5/16	5	4	2	2 1/2	5	9 1/4
2	5	1	0	2	7 3/8	5	5	2	2 15/16	5	10 3/8
2	6	1	7/16	2	8 1/2	5	6	2	3 5/16	5	11 7/16
2	7	1	13/16	2	9 9/16	5	7	2	3 3/4	6	1/2
2	8	1	1 1/4	2	10 5/8	5	8	2	4 3/16	6	1 5/8
2	9	1	1 11/16	2	11 11/16	5	9	2	4 9/16	6	2 11/16
2	10	1	2 1/16	3	13/16	5	10	2	5	6	3 3/4
2	11	1	2 1/2	3	1 7/8	5	11	2	5 3/8	6	4 7/8
3	0	1	2 15/16	3	2 15/16	6	0	2	5 13/16	6	5 15/16

Extreme caution must be exercised in taking off centers of fittings in these measurements.

Table of Diagonals of 67½° Triangles Measuring from 1 Inch to 10 Feet on the Sides.

Long Leg Ft.	Long Leg In.	Short Leg. Ft.	Short Leg. In.	Diagonal. Ft.	Diagonal. In.	Long Leg Ft.	Long Leg In.	Short Leg. Ft.	Short Leg. In.	Diagonal. Ft.	Diagonal. In.
6	1	2	6¼	6	7	8	1	3	4 3/16	8	9
6	2	2	6⅝	6	8⅛	8	2	3	4 9/16	8	10 1/16
6	3	2	7 1/16	6	9 3/16	8	3	3	5	8	11⅛
6	4	2	7½	6	10¼	8	4	3	5 7/16	9	¼
6	5	2	7⅞	6	11⅜	8	5	3	5 13/16	9	1 5/16
6	6	2	8 5/16	7	7/16	8	6	3	6¼	9	2⅜
6	7	2	8¾	7	1½	8	7	3	6 11/16	9	3½
6	8	2	9⅛	7	2⅝	8	8	3	7 1/16	9	4 9/16
6	9	2	9 9/16	7	3 11/16	8	9	3	7½	9	5⅝
6	10	2	9 15/16	7	4¾	8	10	3	7⅞	9	6¾
6	11	2	10⅜	7	5 13/16	8	11	3	8 5/16	9	7 13/16
7	0	2	10 13/16	7	6 15/16	9	0	3	8¾	9	8⅞
7	1	2	11 3/16	7	8	9	1	3	9⅛	9	10
7	2	2	11⅝	7	9 1/16	9	2	3	9 9/16	9	11 1/16
7	3	3	1/16	7	10 3/16	9	3	3	10	10	⅛
7	4	3	7/16	7	11¼	9	4	3	10⅜	10	1¼
7	5	3	⅞	8	5/16	9	5	3	10 13/16	10	2 5/16
7	6	3	1¼	8	1 7/16	9	6	3	11¼	10	3⅜
7	7	3	1 11/16	8	2½	9	7	3	11⅝	10	4½
7	8	3	2⅛	8	3 9/16	9	8	4	1/16	10	5 9/16
7	9	3	2½	8	4 11/16	9	9	4	7/16	10	6⅝
7	10	3	2 15/16	8	5¾	9	10	4	⅞	10	7¾
7	11	3	3⅜	8	6 13/16	9	11	4	1 5/16	10	8 13/16
8	0	3	3¾	8	7 15/16	10	0	4	1 11/16	10	9⅞

Extreme caution must be exercised in taking off centers of fittings in these measurements.

Table of Diagonals of 60° Triangles Measuring from 1 Inch to 10 Feet on the Sides.

Long Leg Ft. In.	Short Leg Ft. In.	Diagonal Ft. In.	Long Leg Ft. In.	Short Leg Ft. In.	Diagonal. Ft. In.
1″	9/16″	1 1/8″	3′ 1″	1′ 9 3/8″	3′ 6 3/4″
2″	1 1/8″	2 5/16″	3′ 2″	1′ 9 15/16″	3′ 7 7/8″
3″	1 3/4″	3 7/16″	3′ 3″	1′ 10 1/2″	3′ 9″
4″	2 5/16″	4 5/8″	3′ 4″	1′ 11 1/16″	3′ 10 3/16″
5″	2 3/4″	5 3/4″	3′ 5″	1′ 11 11/16″	3′ 11 5/16″
6″	3 7/16″	6 15/16″	3′ 6″	2′ 1/4″	4′ 1/2″
7″	4 1/16″	8 1/16″	3′ 7″	2′ 13/16″	4′ 1 11/16″
8″	4 5/8″	9 1/4″	3′ 8″	2′ 1 3/8″	4′ 2 13/16″
9″	5 3/16″	10 3/8″	3′ 9″	2′ 2″	4′ 3 15/16″
10″	5 3/4″	11 9/16″	3′ 10″	2′ 2 9/16″	4′ 5 1/8″
11″	6 3/8″	12 11/16″	3′ 11″	2′ 3 1/8″	4′ 6 1/4″
12″	6 15/16″	13 13/16″	4′ 0″	2′ 3 11/16″	4′ 7 7/16″
1′ 1″	7 1/2″	1′ 3″	4′ 1″	2′ 4 1/4″	4′ 8 9/16″
1′ 2″	8 1/16″	1′ 4 3/16″	4′ 2″	2′ 4 7/8″	4′ 9 3/4″
1′ 3″	8 11/16″	1′ 5 5/16″	4′ 3″	2′ 5 7/16″	4′ 10 7/8″
1′ 4″	9 1/4″	1′ 6 1/2″	4′ 4″	2′ 6″	5′ 0″
1′ 5″	9 13/16″	1′ 7 5/8″	4′ 5″	2′ 6 5/8″	5′ 1 3/16″
1′ 6″	10 3/8″	1′ 8 3/4″	4′ 6″	2′ 7 3/16″	5′ 2 5/16″
1′ 7″	11″	1′ 9 15/16″	4′ 7″	2′ 7 3/4″	5′ 3 1/2″
1′ 8″	11 9/16″	1′ 11 1/16″	4′ 8″	2′ 8 5/16″	5′ 4 5/8″
1′ 9″	12 1/8″	2′ 1/4″	4′ 9″	2′ 8 7/8″	5′ 5 13/16″
1′ 10″	12 11/16″	2′ 1 3/8″	4′ 10″	2′ 9 1/2″	5′ 6 15/16″
1′ 11″	13 1/4″	2′ 2 9/16″	4′ 11″	2′ 10 1/16″	5′ 8 1/8″
2′ 0″	13 7/8″	2′ 3 11/16″	5′ 0″	2′ 10 5/8″	5′ 9 1/2″
2′ 1″	1′ 2 7/16″	2′ 4 7/8″	5′ 1″	2′ 11 1/4″	5′ 10 1/4″
2′ 2″	1′ 3″	2′ 6″	5′ 2″	2′ 11 13/16″	5′ 11 9/16″
2′ 3″	1′ 3 9/16″	2′ 7 3/16″	5′ 3″	3′ 3/8″	6′ 3/4″
2′ 4″	1′ 4 3/16″	2′ 8 5/16″	5′ 4″	3′ 15/16″	6′ 1 7/8″
2′ 5″	1′ 4 3/4″	2′ 9 1/2″	5′ 5″	3′ 1 1/2″	6′ 3 1/16″
2′ 6″	1′ 5 5/16″	2′ 10 5/8″	5′ 6″	3′ 2 1/8″	6′ 4 3/16″
2′ 7″	1′ 5 7/8″	2′ 11 13/16″	5′ 7″	3′ 2 11/16″	6′ 5 3/8″
2′ 8″	1′ 6 1/2″	3′ 15/16″	5′ 8″	3′ 3 1/4″	6′ 6 1/2″
2′ 9″	1′ 7 1/16″	3′ 2 1/8″	5′ 9″	3′ 3 13/16″	6′ 7 11/16″
2′ 10″	1′ 7 5/8″	3′ 3 1/4″	5′ 10″	3′ 4 7/16″	6′ 8 13/16″
2′ 11″	1′ 8 3/16″	3′ 4 7/16	5′ 11″	3′ 5″	6′ 10″
3′ 0″	1′ 8 3/4″	3′ 5 9/16	6′ 0″	3′ 5 9/16″	6′ 11 1/8″

Extreme caution must be exercised in taking off centers of fittings in these measurements.

Table of Diagonals of 60° Triangles Measuring from 1 Inch to 10 Feet on the Sides.

Long Leg Ft. In.	Short Leg Ft. In.	Diagonal Ft. In.	Long Leg Ft. In.	Short Leg Ft. In.	Diagonal Ft. In.
6′ 1″	3′ 6⅛″	7′ ¼″	8′ 1″	4′ 8″	9′ 4″
6′ 2″	3′ 6¾″	7′ 1⁷⁄₁₆″	8′ 2″	4′ 8⁹⁄₁₆″	9′ 5⅛″
6′ 3″	3′ 7⁵⁄₁₆″	7′ 2⁹⁄₁₆″	8′ 3″	4′ 9⅛″	9′ 6⁵⁄₁₆″
6′ 4″	3′ 7⅞″	7′ 3¾″	8′ 4″	4′ 9¾″	9′ 7⁷⁄₁₆″
6′ 5″	3′ 8⁷⁄₁₆″	7′ 4⅞″	8′ 5″	4′ 10⁵⁄₁₆″	9′ 8⅝″
6′ 6″	3′ 9″	7′ 6¹⁄₁₆″	8′ 6″	4′ 10⅞″	9′ 9¾″
6′ 7″	3′ 9⅝″	7′ 7³⁄₁₆″	8′ 7″	4′ 11⁷⁄₁₆″	9′ 10¹⁵⁄₁₆″
6′ 8″	3′ 10³⁄₁₆″	7′ 8⅜″	8′ 8″	5′ ¹⁄₁₆″	10′ ¹⁄₁₆″
6′ 9″	3′ 10¾″	7′ 9½″	8′ 9″	5′ ⅝″	10′ 1¼″
6′ 10″	3′ 11⁵⁄₁₆″	7′ 10¹¹⁄₁₆″	8′ 10″	5′ 1³⁄₁₆	10′ 2⅜″
6′ 11″	3′ 11¹⁵⁄₁₆″	7′ 11¹³⁄₁₆″	8′ 11″	5′ 1¾″	10′ 3⁹⁄₁₆″
7′ 0″	4′ ½″	8′ 1″	9′ 0″	5′ 2⅜″	10′ 4¹¹⁄₁₆″
7′ 1″	4′ 1¹⁄₁₆″	8′ 2⅛″	9′ 1″	5′ 2¹⁵⁄₁₆″	10′ 5¹³⁄₁₆″
7′ 2″	4′ 1⅝″	8′ 3⁵⁄₁₆″	9′ 2″	5′ 3½″	10′ 7″
7′ 3″	4′ 2¼″	8′ 4⁷⁄₁₆″	9′ 3″	5′ 4¹⁄₁₆″	10′ 8³⁄₁₆″
7′ 4″	4′ 2¹³⁄₁₆″	8′ 5⅝″	9′ 4″	5′ 4⅝″	10′ 9⁵⁄₁₆″
7′ 5″	4′ 3⅜″	8′ 6¾″	9′ 5″	5′ 5¼″	10′ 10½″
7′ 6″	4′ 3¹⁵⁄₁₆″	8′ 7¹⁵⁄₁₆″	9′ 6″	5′ 5¹³⁄₁₆″	10′ 11⅝″
7′ 7″	4′ 4½″	8′ 9¹⁄₁₆″	9′ 7″	5′ 6⅜″	11′ ¾″
7′ 8″	4′ 5⅛″	8′ 10¼″	9′ 8″	5′ 7″	11′ 1¹⁵⁄₁₆′
7′ 9″	4′ 5¹¹⁄₁₆″	8′ 11⅜″	9′ 9″	5′ 7⁹⁄₁₆″	11′ 3¹⁄₁₆″
7′ 10″	4′ 6¼″	9′ ½″	9′ 10″	5′ 8⅛″	11′ 4¼″
7′ 11″	4′ 6⅞″	9′ 1¹¹⁄₁₆″	9′ 11″	5′ 8¹¹⁄₁₆″	11′ 5⅜″
8′ 0″	4′ 7⁷⁄₁₆″	9′ 2⅞″	10′ 0″	5′ 9¼″	11′ 6⁹⁄₁₆″

Extreme caution must be exercised in taking off centers of fittings in these measurements.

Table of Diagonals of 72° Triangles Measuring from 1 Inch to 10 Feet on the Sides.

Long Leg Ft. In.	Short Leg Ft. In.	Diagonal. Ft. In.	Long Leg Ft. In.	Short Leg Ft. In.	Diagonal. Ft. In.
1"	⅜"	1¹⁄₁₆"	3' 1"	1' 0"	3' 2⅞"
2"	⅝"	2⅛"	3' 2"	1' ⅜"	3' 4"
3"	1"	3⅛"	3' 3"	1' ⅝"	3' 5"
4"	1¼"	4¼"	3' 4"	1' 1"	3' 6"
5"	1⅝"	5¼"	3' 5"	1' 1¼"	3' 7⅛"
6"	2"	6¼"	3' 6"	1' 1⅝"	3' 8⅛"
7"	2¼"	7⅜"	3' 7"	1' 2"	3' 9¼"
8"	2⅝"	8⅜"	3' 8"	1' 2¼"	3' 10¼"
9"	2⅞"	9½"	3' 9"	1' 2⅝"	3' 11⅜"
10"	3¼"	10½"	3' 10"	1' 3"	4' ⅜"
11"	3⅝"	11½"	3' 11"	1' 3¼"	4' 1⅜"
12"	3⅞"	12⅝"	4' 0"	1' 3⅝"	4' 2½"
1' 1"	4¼"	1' 1⅝"	4' 1"	1' 3⅞"	4' 3½"
1' 2"	4½"	1' 2¾"	4' 2"	1' 4¼"	4' 4⅝"
1' 3"	4⅞"	1' 3¾"	4' 3"	1' 4⅝"	4' 5⅝"
1' 4"	5¼"	1' 4⅞"	4' 4"	1' 4⅞"	4' 6⅝"
1' 5"	5½"	1' 5⅞"	4' 5"	1' 5¼"	4' 7¾"
1' 6"	5⅞"	1' 6⅞"	4' 6"	1' 5½"	4' 8¾"
1' 7"	6⅛"	1' 8"	4' 7"	1' 5⅞"	4' 9⅞"
1' 8"	6½"	1' 9"	4' 8"	1' 6¼"	4' 10⅞"
1' 9"	6⅞"	1' 10⅛"	4' 9"	1' 6½"	4' 11⅞"
1' 10"	7⅛"	1' 11⅛"	4' 10"	1' 6⅞"	5' 1"
1' 11"	7½"	2' ⅛"	4' 11"	1' 7⅛"	5' 2"
2' 0"	7¾"	2' 1¼"	5' 0"	1' 7½"	5' 3⅛"
2' 1"	8⅛"	2' 2¼"	5' 1"	1' 7⅞"	5' 4⅛"
2' 2"	8½"	2' 3⅜"	5' 2"	1' 8⅛"	5' 5¼"
2' 3"	8¾"	2' 4⅜"	5' 3"	1' 8½"	5' 6¼"
2' 4"	9⅛"	2' 5⅜"	5' 4"	1' 8¾"	5' 7¼"
2' 5"	9⅜"	2' 6½"	5' 5"	1' 9⅛"	5' 8⅜"
2' 6"	9¾"	2' 7½"	5' 6"	1' 9½"	5' 9⅜"
2' 7"	10⅛"	2' 8⅝"	5' 7"	1' 9¾"	5' 10½"
2' 8"	10⅜"	2' 9⅝"	5' 8"	1' 10⅛"	5' 11½"
2' 9"	10¾"	2' 10¾"	5' 9"	1' 10⅜"	6' ½"
2' 10"	11"	2' 11¾"	5' 10"	1' 10¾"	6' 1½"
2' 11"	11⅜"	3' ¾"	5' 11"	1' 11⅛"	6' 2⅝"
3' 0"	11¾"	3' 1⅞"	6' 0"	1' 11⅜"	6' 3⅝"

Extreme caution must be exercised in taking off centers of fittings in these measurements.

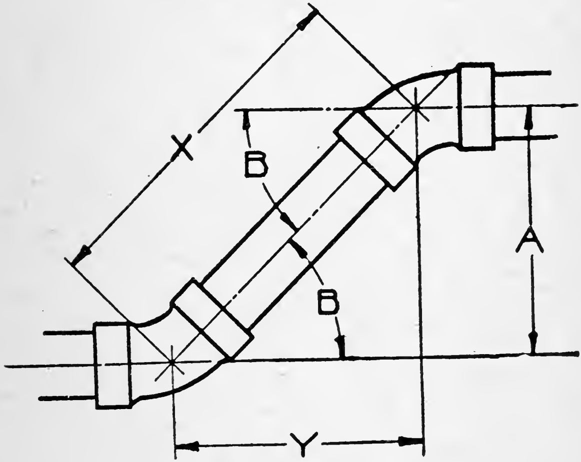
Table of Diagonals of 72° Triangles Measuring from 1 Inch to 10 Feet on the Sides.

Long Leg Ft. In.	Short Leg Ft. In.	Diagonal. Ft. In.	Long Leg Ft. In.	Short Leg Ft. In.	Diagonal, Ft. In.
6′ 1″	1′ 11¾″	6′ 4¾″	8′ 1″	2′ 7½″	8′ 6″
6′ 2″	2′ 0″	6′ 5¾″	8′ 2″	2′ 7⅞″	8′ 7″
6′ 3″	2′ ⅜″	6′ 6⅞″	8′ 3″	2′ 8⅛″	8′ 8⅛″
6′ 4″	2′ ¾″	6′ 7⅞″	8′ 4″	2′ 8½″	8′ 9⅛″
6′ 5″	2′ 1″	6′ 8⅞″	8′ 5″	2′ 8⅞″	8′ 10¼″
6′ 6″	2′ 1⅜″	6′ 10″	8′ 6″	2′ 9⅛″	8′ 11¼″
6′ 7″	2′ 1⅝″	6′ 11⅛″	8′ 7″	2′ 9½″	9′ ¼″
6′ 8″	2′ 2″	7′ ⅛″	8′ 8″	2′ 9¾″	9′ 1⅜″
6′ 9″	2′ 2⅜″	7′ 1⅛″	8′ 9″	2′ 10⅛″	9′ 2⅜″
6′ 10″	2′ 2⅝″	7′ 2½″	8′ 10″	2′ 10½″	9′ 3½″
6′ 11″	2′ 3″	7′ 3¼″	8′ 11″	2′ 10¾″	9′ 4¼″
7′ 0″	2′ 3¼″	7′ 4⅜″	9′ 0″	2′ 11⅛″	9′ 5½″
7′ 1″	2′ 3⅝″	7′ 5⅜″	9′ 1″	2′ 11⅜″	9′ 6⅝″
7′ 2″	2′ 4″	7′ 6⅜″	9′ 2″	2′ 11¾″	9′ 7⅝″
7′ 3″	2′ 4½″	7′ 7½″	9′ 3″	3′ ⅛″	9′ 8¾″
7′ 4″	2′ 4⅝″	7′ 8½″	9′ 4″	3′ ⅜″	9′ 9¾″
7′ 5″	2′ 4⅞″	7′ 9½″	9′ 5″	3′ ¾″	9′ 10⅞″
7′ 6″	2′ 5¼″	7′ 10⅝″	9′ 6″	3′ 1″	9′ 11⅞″
7′ 7″	2′ 5⅝″	7′ 11⅝″	9′ 7″	3′ 1⅜″	10′ ⅞″
7′ 8″	2′ 5⅞″	8′ ¾″	9′ 8″	3′ 1¾″	10′ 2″
7′ 9″	2′ 6¼″	8′ 1¾″	9′ 9″	3′ 2″	10′ 3″
7′ 10″	2′ 6½″	8′ 2¾″	9′ 10″	3′ 2⅜″	10′ 4⅛″
7′ 11″	2′ 6⅞″	8′ 3⅞″	9′ 11″	3′ 2⅝″	10′ 5⅛″
8′ 0″	2′ 7¼″	8′ 5″	10′ 0″	3′ 3″	10′ 6⅛″

Extreme caution must be exercised in taking off centers of fittings in these measurements.

Formula For Offset Connections

Used in General Practice



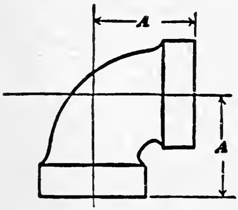
X (Center to Center) = A (Offset) Multiplied by Constant.

Y (Center to Center) = A (Offset) Multiplied by Constant.

B—Angle	Constant	
	For X	For Y
60 Degrees........................	1.15	.58
45 Degrees........................	1.41	1.00
30 Degrees........................	2.00	1.73
22½ Degrees........................	2.61	2.41
11¼ Degrees........................	5.12	5.02
5⅝ Degrees........................	10.20	10.15

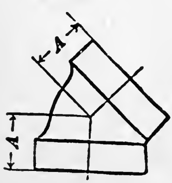
Measurements of Elbows and 45° Elbows from 1¼ in. to 8 in. Inclusive.

Extreme caution must be exercised in allowing for thread.



90° Long Turn Elbows.

Size.. Inches	1¼	1½	2	2½	3	4	5	6	7	8
Dimen. A In.	2¼	2½	3 1/16	3 11/16	4¼	5 3/16	6⅛	7⅛	8⅛	9



45° Elbows.

Size Inches	1¼	1½	2	2½	3	4	5	6	7	8
Dimen. A In.	1⅜	1 7/16	1¾	2 1/16	2⅜	2¾	3 3/16	3½	3⅞	4 3/16

TABLE OF SIZE OF DRILL TO BE USED FOR DRILLING HOLES FOR DIFFERENT SIZES OF IRON PIPE SIZE TAPS.

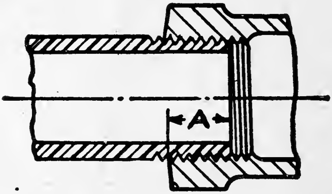
Diam. of Pipe					
Nominal Inside	Actual Inside	Actual Outside	Number of Threads	Length of Thread	Size of Drill to be Used
1/8"	0.270	0.405	27	1/4"	5/16"
1/4"	0.364	0.540	18	3/8"	29/64
3/8"	0.494	0.675	18	3/8"	19/32"
1/2"	0.623	0.840	14	1/2"	23/32"
3/4"	0.824	1.051	14	1/2"	15/16"
1"	1.048	1.315	11 1/2	9/16"	1 3/16"
1 1/4"	1.380	1.660	11 1/2	5/8"	1 5/32"
1 1/2"	1.610	1.900	11 1/2	5/8"	1 23/32"
2"	2.067	2.375	11 1/2	11/16"	2 3/16"
2 1/2"	2.468	2.875	8	15/16"	2 11/16
3"	3.067	3.500	8	1"	3 5/16"

SIZE OF DRILL TO BE USED FOR DIFFERENT SIZES OF MACHINE BOLT TAPS.

Size of Tap	Number of Threads	Size of Drill.
1/4"	20 Per Inch.	3/16"
5/16	18 " "	1/4"
3/8"	16 " "	19/64"
7/16"	14 " "	23/64"
1/2"	13 " "	13/32"
9/16"	12 " "	15/32"
5/8"	11 " "	33/64"
3/4"	10 " "	5/8"
7/8"	9 " "	47/64"
1"	8 " "	27/32
1 1/8"	7 " "	61/64"
1 1/4"	7 " "	1 5/64"

LENGTH OF THREAD ON PIPE

THAT IS SCREWED INTO VALVES OR FITTINGS TO MAKE A TIGHT JOINT



Size Inches	Dimension A Inches	Size Inches	Dimension A Inches
1/8	1/4	3 1/2	1 1/16
1/4	3/8	4	1 1/16
3/8	3/8	4 1/2	1 1/8
1/2	1/2	5	1 3/16
3/4	1/2	6	1 1/4
1	9/16	7	1 1/4
1 1/4	5/8	8	1 5/16
1 1/2	5/8	9	1 3/8
2	11/16	10	1 1/2
2 1/2	13/16	12	1 5/8
3	1		

DIMENSIONS GIVEN DO NOT ALLOW FOR VARIATION IN TAPPING OR THREADING

Offset Connections

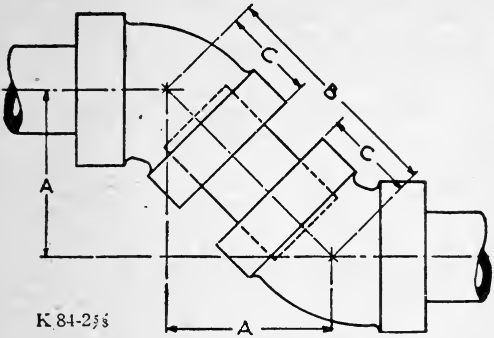


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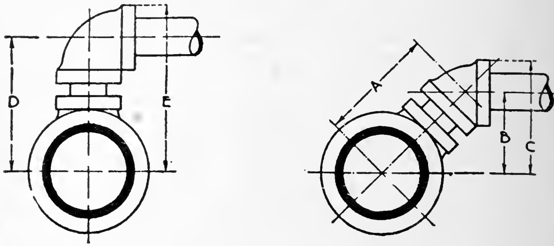
TABLE-45 DEGREE OFFSETS								
	CLOSE NIPPLE				SHORT NIPPLE			
Pipe Size	Length of Nipple	Off-set A	Center to Center B	Center to Face C	Length of Nipple	Off-set A	Center to Center B	Center to Face C
1/2	1 1/8	1 5/16	1 7/8	7/8	1 1/2	1 9/16	2 1/4	7/8
3/4	1 3/8	1 11/16	2 3/8	1	2	2 3/16	3	1
1	1 1/2	1 7/8	2 5/8	1 1/8	2	2 1/4	3 1/8	1 1/8
1 1/4	1 5/8	2 1/8	3	1 5/16	2 1/2	2 3/4	3 7/8	1 5/16
1 1/2	1 3/4	2 3/8	3 3/8	1 7/16	2 1/2	2 15/16	4 1/8	1 7/16
2	2	2 13/16	4	1 11/16	2 1/2	3 3/16	4 1/2	1 11/16
2 1/2	2 1/2	3 3/16	4 1/2	1 15/16	3	3 9/16	5	1 15/16
3	2 5/8	3 9/16	5	2 3/16	3	3 13/16	5 3/8	2 3/16
3 1/2	2 3/4	3 13/16	5 3/8	2 3/8	4	4 11/16	6 5/8	2 3/8
4	3	4 5/16	6 1/8	2 5/8	4	5 1/16	7 1/8	2 5/8
4 1/2	3	4 1/2	6 3/8	2 13/16	4	5 3/16	7 3/8	2 13/16
5	3 1/4	4 15/16	7	3 1/16	4 1/2	5 13/16	8 1/4	3 1/16
6	3 1/4	5 3/8	7 5/8	3 7/16	4 1/2	6 1/4	8 7/8	3 7/16
7	3 1/2	6 3/16	8 3/4	3 7/8	5	7 1/4	10 1/4	3 7/8
8	3 1/2	6 5/8	9 3/8	4 1/4	5	7 11/16	10 7/8	4 1/4
The Offset "A" Is Equal To The Distance "B" Divided By 1.414								

Space Required for Branch Connections



Minimum Height of Connections Off Pipe Mains

Mains Inches	Branches Inches	A In.	B In.	C In.	D In.	E In.	Branches Inches	Mains Inches
2	1	3 3/8	2 3/8	3 13/32	3 31/32	5	1	2
2	1¼	3 11/16	2 5/8	3 7/8	4 7/16	5 11/16	1¼	2
2	1½	4	2 27/32	4 7/32	4 13/16	6 3/16	1½	2
2½	1	3¾	2 21/12	3 11/16	4 11/32	5 3/8	1	2½
2½	1¼	4 1/16	2 7/8	4 1/8	4 13/16	6 1/16	1¼	2½
2½	1½	4 3/8	3 3/32	4 15/32	5 3/16	6 9/16	1½	2½
2½	2	4 7/8	3 7/16	5 1/8	5 7/8	7 9/16	2	2½
3	1	4 1/16	2 7/8	3 29/32	4 21/32	5 11/16	1	3
3	1¼	4 3/8	3 3/32	4 11/32	5 1/8	6 3/8	1¼	3
3	1½	4 11/16	3 5/16	4 11/16	5½	6 7/8	1½	3
3	2	5 5/16	3 11/16	5 3/8	6 3/16	7 7/8	2	3
3	2½	5 9/16	3 15/16	6	6 13/16	8 7/8	2½	3
3½	1	4 11/32	3 1/16	4 3/32	4 15/16	5 11/32	1	3½
3½	1¼	4 21/32	3 5/16	4 9/16	5 13/32	6 21/32	1¼	3½
3½	1½	4 31/32	3 17/32	4 29/32	5 25/32	7 5/12	1½	3½
3½	2	5 15/32	3 7/8	5 9/16	6 15/32	8 5/12	2	3½
3½	2½	5 27/32	4 1/8	6 1/16	7 3/32	9 5/32	2½	3½
4	1	4 11/16	3 5/16	4 11/32	5 9/32	6 5/16	1	4
4	1¼	5	3 17/12	4 25/32	5¾	7	1¼	4
4	1½	5 5/16	3¾	5 1/8	6 1/5	7½	1½	4
4	2	5 13/16	4 1/8	5 13/16	6 13/16	8½	2	4
4	2½	6 3/16	4 3/8	6 7/16	7 7/16	9½	2½	4
5	1¼	5 17/32	3 29/12	5 5/32	6 9/32	7 17/32	1¼	5
5	1½	5 27/32	4 1/8	5½	6 21/32	8 1/32	1½	5
5	2	6 11/32	4½	6 3/16	7 11/32	9 1/32	2	5
5	2½	6 23/32	4¾	6 13/16	7 31/32	10 1/32	2½	5
6	1¼	6 3/16	4 3/8	5 5/8	6 15/16	8 3/16	1¼	6
6	1½	6½	4 5/8	6	7 5/16	8 11/16	1½	6
6	2	7	4 11/32	6 21/32	8	9 11/16	2	6
6	2½	7 3/8	5 7/32	7 9/32	8 5/8	10 11/16	2½	6
8	2	8¼	5 27/32	7 17/32	9¼	10 [illegible]	2	8
8	2½	8 5/8	6 1/8	8 3/16	9 7/8	11 [illegible]		8
8	3	9	6 3/8	8¾	10 7/16	12 13/16		8

The above table prepared by Fred'k D. B. Ingalls, [illegible] E., indicates dimensions of branch connections when made up a[illegible] close as possible with space nipple between tee on main and branch nipple.

CHART
SHOWING THE MINIMUM LENGTH OF FACE TO CENTER OF DRAINAGE FITTINGS.

(CASE A) WHEN DIRECTION OF FLOW CHANGES FROM HORIZONTAL TO VERTICAL.

SIZE OF PIPE	1¼"	1½"	2"	2½"	3"	4"	5"	6"
DISTANCE FROM FACE TO CENTER (A)	1¾"	2 3/16"	2⅜"	2 13/16"	3 3/16"	3 13/16"	4½"	5 3/16"

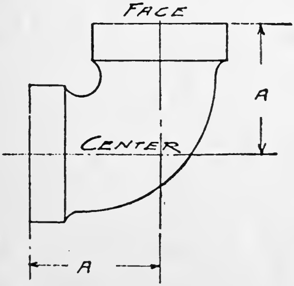
(CASE B) WHEN DIRECTION OF FLOW CHANGES FROM VERTICAL TO HORIZONTAL

SIZE OF PIPE	1¼"	1½"	2"	2½"	3"	4"	5"	6"
DISTANCE FROM FACE TO CENTER (A)	2¼"	2½"	3 1/16"	3 11/16"	4¼"	5 3/16"	6⅛"	7⅛"

(CASE C) WHEN DIRECTION OF FLOW CHANGES FROM HORIZONTAL TO HORIZONTAL

USE SAME DISTANCE FROM FACE TO CENTER AS IN CASE B.

<u>NOTE</u>. LONG TURN Y BRANCHES OR Y AND ⅛ BEND ARE RECOMMENDED.



How End of Pipe Should be Reamed

If the ordinary style of fittings are used on hot water circulating systems, such as are not recessed, all ends of pipes should be carefully reamed out in a manner as shown in illustration, Fig. 22, and unless the ends of pipes are reamed, taking off at least the burr, there will not only be a large amount of fric-

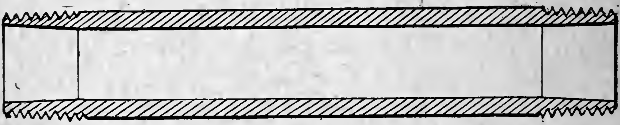


Fig. 22.

tion due to such obstructions, but the capacity of the pipe will be greatly reduced by the burrs contracting the area of the pipes at each end; and while the average fitter might consider this a small matter, and in a measure a waste of time to ream the ends of pipes, he is working against his own interests if he desires to construct a good, easy, and economical working heating plant. It more than pays, in fact it is a good investment to carefully construct the pipe work of a hot water heating plant, and avoid as much as possible any cause of friction to the movement of the water.

Outside Diameter of Standard Wrought Iron, Steam, Gas and Water Pipe. From 1-8 to 10 Inches.

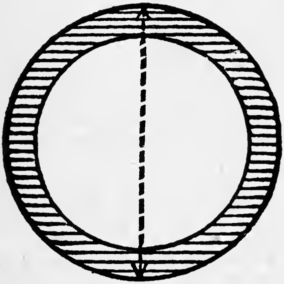


Fig. 25.

Size of pipe...........	$\frac{1}{8}$	$\frac{1}{4}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{3}{4}$
Outside diam. of pipe..	$\frac{40}{100}$	$\frac{54}{100}$	$\frac{67}{100}$	$\frac{84}{100}$	$1\frac{5}{100}$
Size of pipe...........	1	$1\frac{1}{4}$	$1\frac{1}{2}$	2	$2\frac{1}{2}$
Outside diam. of pipe..	$1\frac{31}{100}$	$1\frac{66}{100}$	$1\frac{90}{100}$	$2\frac{37}{100}$	$2\frac{87}{100}$
Size of pipe...........	3	$3\frac{1}{2}$	4	$4\frac{1}{2}$	5
Outside diam. of pipe..	$3\frac{50}{100}$	$4\frac{00}{100}$	$4\frac{50}{100}$	$5\frac{00}{100}$	$5\frac{56}{100}$
Size of pipe...........	6	7	8	9	10
Outside diam. of pipe..	$6\frac{62}{100}$	$7\frac{62}{100}$	$8\frac{62}{100}$	$9\frac{68}{100}$	$10\frac{77}{100}$

Number of threads to the inch of screw on American standard wrought iron, steam, gas and water pipe, from ⅛ to 10 inches.

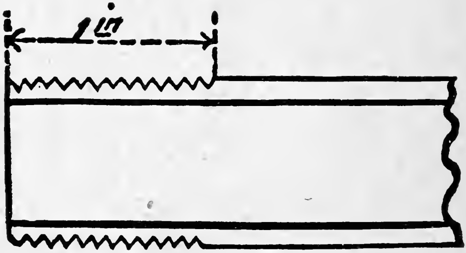


Fig. 42.

Size of pipe	⅛	¼	⅜	½	¾
Number of threads per inch	27	18	18	14	14
Size of pipe	1	1¼	1½	2	2½
Number of threads per inch	11½	11½	11½	11½	8
Size of pipe	3	3½	4	4½	5
Number of threads per inch	8	8	8	8	8
Size of pipe	6	7	8	9	10
Number of threads per inch	8	8	8	8	8

USEFUL INFORMATION

Minimum Sizes of Local Vent Pipe Stacks.

Size of Pipe	Maximum developed length in feet Mains	Number of Closets vented Vent Branches	Main Vertical Vent
2 inches	400	1	1
3 inches	100	3	6
4 inches	150	6	12
5 inches	200	10	20
6 inches	250	16	32
7 inches	300	23	46
8 inches	350	32	64
9 inches	400	42	84
10 inches	450	56	112
11 inches	500	72	144
12 inches	550	90	180

The Boiling Point of Water.

Water boils at different temperatures, according to the elevation above the sea level. In New York water boils practically at 212 degrees Fahenheit; in Munich, Germany, at 209½ degrees; in the City of Mexico, at 200 degrees, and in the Himalayas, at an elevation of 18,000 feet above the level of the sea, at 180 degrees. These differences are caused by the varying pressure of the atmosphere at these points. In New York the whole weight of the air has to be overcome.

In Mexico, 7,000 feet above the sea, there is 7,000 feet less of atmosphere to be resisted; consequently less heat is required and boiling takes place at a lower temperature.

Liquid Measure.

4 gills make 1 pint.
2 pints make 1 quart.
4 quarts make 1 gallon.
31½ gallons make 1 barrel.

Boiling Points of Various Fluids.

Water in Vacuum	98°
Water, Atmospheric Pressure	212°
Alcohol	173°
Sulphuric Acid	240°
Refined Petroleum	316°
Turpentine	315°
Sulphur	570°
Linseed Oil	597°

Melting Points of Different Metals.

Aluminum	1400°
Antimony	1150°
Bismuth	507°
Brass	1900°
Bronze	1692°
Copper	1996°
Glass	2377°
Gold (pure)	2066°
Iron (cast)	2786°
Iron (wrought)	2912°
Lead	617°
Platinum	3080°
Silver (pure)	1873°
Steel	2500°
Tin	446°
Zinc	773°

Weights and Measures.

Measure of Length.

4	inches	make	1 hand.
7.92	inches	make	1 link.
18	inches	make	1 cubit.
12	inches	make	1 foot.
6	feet	make	1 fathom.
3	feet	make	1 yard.
5½	yards	make	1 rod or pole.

Measure of Length—Continued.

40 poles make 1 furlong.
8 furlongs make 1 mile.
69 1/6 miles make 1 degree.
60 geographical miles make 1 degree.
1760 yards } 1 mile.
5280 feet }

Measure of Surface.

144 square inches make 1 square foot.
9 square feet make 1 square yard.
30 1/4 square yards make 1 rod, perch or pole.
40 square rods make 1 square rood.
4 square roods make 1 square acre.
10 square chains make 1 square acre.
640 square acres make 1 square mile.
Gunter's chain equal to 22 yards or 100 links.
272 1/4 square feet make 1 square rod.
43,560 square feet make 1 acre.

Measure of Solidity.

1728 cubic inches make 1 cubic foot.
27 cubic feet make 1 cubic yard.

To Remove Stains from Marble.

Take two parts of soda, one of pumice and one of finely powdered chalk. Sift through a fine sieve and mix into a paste with water. Rub this composition all over the marble and the stain will be removed. Wash it with soap and water, and a beautiful bright polish will be produced.

To Clean Marble.

Mix up a quantity of the strongest soaplees and quicklime to the consistency of milk; lay it on the stone for 24 hours; clean it and it will appear as new. To further improve, rub with fine putty powder and olive oil.

Ordinary atmosphere will sustain 33.9 ft. of water in height.

35.84 cu. ft of water=1 ton.

39.84 cu. ft. of ice=1 ton.

1 cu. ft. of sea water=64.3 ℔.

Sea water contains 4 to 5 oz. of salt per gallon.

Weights of Different Metals.

Lead	1 foot square, inch thick	=59.06
Copper	1 foot square, inch thick	=45.3
Wrought-iron	1 foot square, inch thick	=40.5
Cast-iron	1 foot square, inch thick	=37.54
Cast-steel	1 foot square, inch thick	=40.83

Under no consideration should lead be used in fittings as lead has a tendency to stop the circulation in time. A good practical man will always lead on the threads.

Pipe and Fittings.

Use ample-sized pipe. If one or two sizes large it will not be detrimental to the successful circulation of the steam or water, but if too small will in all probability cause failure. Pipes of ample size are the most satisfactory and economical in the long run. Use fittings which will allow of the free and rapid circulation of the steam or water, connecting them in such a manner as to permit proper expansion and contraction of the pipe.

Shrinkage of Castings.

Pattern-makers' rule for	Cast-Iron	1/8	of an inch longer per linear foot.
" " " "	Brass	3/16	
" " " "	Lead	1/8	
" " " "	Tin	1/12	
" " " "	Zinc	3/16	

To find the diameter of a pump cylinder to move a given quantity of water per minute (100 feet of piston being the speed), divide the number of gallons by 4, then extract the square root, and the result will be the diameter in inches.

Metal That Expands in Cooling.

Lead, 75; antimony, 16.7; and bismuth, 18.3.

Expansion of solids from 32° to 212°, at 32° being equal to 1.

Brass	1.00191
Common brick	1.00055
Cast iron	1.00111
Cement	1.00144
Copper	1.00175
Fire brick	1.0175
Glass	1.00085
Geanite	1.00079

Water expands .1 of its bulk in freezing.

A column of water 2.3 ft. high equals 1 lb. per sq. in. pressure.

Things We All Should Know.

If back outlet closets and graduated fittings are used when installing a battery of closets, it will be unnecessary to put in a raised floor. These closets and fittings are carried in stock by the leading supply houses, and the fittings are of sufficient length to allow one to each closet without the necessity of using pieces of soil pipe between the fittings.

In estimating water for factory supply, allow 100 gallons per day per capita.

Soft water cisterns must be ventilated to prevent stagnation.

Storage tanks should have an extra large sediment draw off cock to be used solely for cleaning tank. It is a regretable fact that the majority of storage tanks are seldom cleaned.

Hammering, rumbling or snapping in the range boiler or hot water pipes is caused from sagging of the pipes, causing traps or dips or from stoppage in the water front.

Water fronts should never be connected directly to the city pressure. The cold water supply to the water front should be taken from the bottom of the range boiler.

Use a small offset between sink and sink trap as shown in Fig. 43, page 96. This will prevent the annoying constant dripping noise in the sink.

Very often it will be found economical to waste all the fixtures but the closet, into the 2″ sink stack. In cases of this kind the closet need not be revented as it is the only fixture wasting into the 4″ stack.

House sewers should have a pitch of ¼″ to the foot.

Automatic closets and urinals should always be used in schools and factories.

In cities where the water pressure is increased in case of fire, a pressure regulator should be used, or the house should be supplied from a tank in the attic. If the tank system is used, the extra fire pressure does not affect the fixtures or piping.

It is poor practice to connect sediment pipe from range boiler to the sink trap. It is far better to use a compression bibb, as this precludes the possibility of waste, and the plumber knows for certainty that the system is drained.

File or drill a small hole in boiler tube about 6″ from the top to prevent syphonage of boiler.

The circulating pipe should be of the same size as the flow pipe, and to insure best results, take supply to fixtures from return or circulating pipe.

Hot water faucets should be at the left hand when facing the fixture.

Stops should never be used on range boiler supply. Always use stop with waste to give vent to boiler when water is shut off.

Coils in furnaces should be placed above the bed of fire, not in it.

Check Valves Should Never be Used on Circulation.

While this is true as a general proposition, there are some cases where a check valve is necessary, to prevent the water from reversing in the circulating pipe. In cases of this kind use a horizontal check valve and place it as near the boiler as possible. The check valve should be installed so that the water cannot flow through check valve from boiler.

Size of Pipe	Branch Soil Pipe Water Closets.	Main Soil Pipe Water Closets
2 inches	...	...
3 inches	...	...
4 inches	8	16
5 inches	18	36
6 inches	36	72
7 inches	63	126
8 inches	105	210

Minimum Sizes of Soil and Waste Pipes.

Size of Pipe.	Branch Waste and Connecting Soil Pipe. Fixtures.	Main Waste and Connecting Soil Pipe. Fixtures.
2 inches	3	4
3 inches	4	8
4 inches	32	64
5 inches	72	144
6 inches	144	288
7 inches	252	504
8 inches	420	840

Hammering or jarring in the pipes may be caused by a loose part of one of the faucets or ball cocks. A loose Fuller ball or washer will cause a rattling in pipes that can be heard throughout the house.

Doubling the size of pipes increases the capacity four times, because capacities of pipes are to each other as the ratio of their squares. Thus the capacity of 4″ pipe is 4 times as great as the capacity of 2″ pipe. The capacity of 6″ pipe is 9 times as great as the capacity of 2″ pipe. The method of reaching these conclusions is as follows: The large pipe 4″ multiplied by itself, $4 \times 4 = 16$. The small pipe, 2″ multiplied by itself $2 \times 2 = 4$. $16 \div 4 = 4$: Therefore the capacity of 4″ pipe is 4 times as great as the capacity of 2″. $6 \times 6 = 36$. $2 \times 2 = 4$. $36 \div 4 = 9$. Therefore the capacity of 6″ pipe is 9 times as great as the capacity of 2″.

To multiply feet and inches by feet and inches, without reducing to inches. This is useful to the plumber in figuring marble.

For example take 4 ft. 6 in. by 6 ft. 3 in.

4 — 6		4 ft.x6 ft.=	24 ft.
6 — 3		6 in.x6 ft.=36 in. or	3 ft.
24	1½	4 ft.x3 in.=12 in. or	1 ft.
3		6 in.x3 in.=18/12 in. or	1½ in.
1			
			Total......28 ft. 1½ in.
28 — 1½			

An insertable joint will save time and trouble in cases where it is necessary to break into a stack.

Expansion and Contraction.

Scarcely anything can withstand the expansion of iron. It expands from 32° to 212°, about 1-900 of its length, which in 100 feet equals 1⅜ inches. The expanding power of a 2″ pipe when heated to a temperature of 100 pounds steam, or 338°, exerts a force sufficient to move 25 tons.

Cast iron expands 1/162000 of its length for each degree Fahr. It is subjected to within ordinary limits while in its solid state.

Wrought iron expands 1/150000 of its length for each degree Fahr. To find the expansion of a line of pipe, multiply its length in inches by the number of degrees of temperature applied and divide the product by 150,000 for required expansion in inches; thus $100' \times 12'' = 1200 \times 338° = 405600 \div 150000 = 2.7$ inches.

Special attention, then, must be given to the expansion and contraction of pipes and allowance made for it.

Expansion joints should not be used if the expansion can be compensated for in any other way.

		PRESSURE STAND PIPE	
Allow for thread to screw tight in fitting	Size of opening for tapping (inches)	Bursting pressure (pounds)	Working pressure factor Safety 6 (pounds)
5/16	11/32	25,182	4,197
3/8	29/64	24,174	4,029
3/8	19/32	18,420	3,070
9/16	23/32	17,490	2,915
9/16	15/16	13,704	2,284
5/8	1 3/16	12,780	2,130
5/8	1 1/2	10,140	1,690
3/4	1 3/4	9,000	1,500
3/4	2 3/16	7,000	1,240
7/8	2 11/16	8,262	1,377
7/8	3 5/16	7,080	1,180
7/8	3 13/16	6,366	1,061
1	4 5/16	5,880	980
1	4 3/4	5,460	910
1 1/8	5 5/16	5,130	855
1 1/8	6 5/16	4,614	769
1 1/4	7 3/8	4,290	715
1 1/4	8 3/8	4,926	671
1 1/2	9 5/8	3,846	641
1 5/8	10 7/16	3,648	608
1 3/4	12 15/32	3,120	520

A gallon of water (U. S. Standard) weighs 8⅓ pounds, and contains 231 cubic inches.

A cubic foot of water weighs 62½ pounds, and contains 1,728 cubic inches, or 7½ gallons.

To find the pressure in pounds per square inch of a column of water, multiply the height of the column in feet by .434. (Approximately, every foot elevation is called equal to one-half pound per square inch.)

To find the capacity of a cylinder in gallons. Multiplying the area in inches by the length of stroke in inches will give the total number of cubic inches; divide the amount by 231 (which is the cubical contents of a gallon in inches), and the quotient is the capacity in gallons.

Ordinary speed to run pumps is 100 feet of piston per minute.

To find quantity of water elevated in one minute running at 100 feet of piston per minute. Square the diameter of water cylinder in inches and multiply by 4. Example: Capacity of a five-inch cylinder is desired; the square of the diameter (5 inches) is 25, which, multiplied by 4, gives 100, which is gallons per minute (approximately).

To find the velocity in feet per minute necessary to discharge a given volume of water in a given time, multiply the number of cubic feet of water by 144, and divide the product by the area of the pipe in inches.

To find the area of a required pipe, the volume and velocity of water being given, multiply the number of cubic feet of water by 144, and divide the product by the velocity in feet per minute. The area being found, it is easy to get the diameter of pipe necessary.

Table Showing Expansion of Iron Pipe for Each 100 Feet, in Inches, from 30 Degrees.

Temperature	Expansion in inches.
165 degrees	1.15
115 degrees	1.47
265 degrees	1.78
297 degrees	2.12
338 degrees	2.45

What a Unit of Heat is.

A unit of heat is that amount of heat which is required to rise the temperature of one pound of water 1 degree F., and is used to calculate and measure the quantity of heat.

Determining Size of Boiler when Pipe Coil is used for Heating Water for Domestic Purposes.

When a pipe coil or cast iron section is introduced into the firepot for the purpose of heating water for domestic use, additional capacity should be figured in determining size of Boiler, viz., in the case of Steam Boilers, 1¼ square feet of direct radiation for each gallon of water to be thus heated, and in the case of Water Boilers, 2 square feet of direct radiation for each gallon of water to be thus heated, according to the capacity of the tank to which coil or section is connected.

HEAT OF COMBUSTION OF FUELS

FUEL	Air chemically consumed per pound of fuel		Total heat of combustion of one pound of fuel	Equivalent evaporative power from and at 212° F., water per pound of fuel
	Lbs.	Cu. ft. at 62° F.	Units	Lbs.
Coal of average composition.	10.7	140	14,700	15.22
Coke	10.81	142	13,548	14.02
Lignite	8.85	116	13,108	13.57
Asphalt	11.85	156	17,040	17.64
Wood desiccated	6.09	80	10,974	11.36
Wood, 25% moisture	4.57	60	7,951	8.20
Wood, charcoal, desiccated	9.51	125	13,006	13.46
Peat, desiccated	7 52	99	12,279	12.71
Peat, 30% moisture	5.24	69	8,260	9.53
Peat, charcoal, desiccated	9.9	130	12,325	12.76
Straw	4.26	56	8,144	8.43
Petroleum	10.33	188	20,411	21.13
Petroleum oils	17.33	235	27,531	28.50
Coal gas per cu. ft. at 62° F.	....	....	630	.70

RELATIVE VALUE OF VARIOUS WOODS

WOOD	Specific Gravity	One Cubic Foot	Pounds in one Cord	Relative value of Wood	Val. with Hickory at $5.00 per Cord
Hickory Shell bark	1.000	62	4,469	1.00	$5.00
White Oak	0.885	53	3,821	0.81	4.05
White Ash	0.772	49	3,450	0.77	3.85
Red Oak	0.728	45½	3,254	0.69	4.45
White Beech	0.724	45	3,236	0.65	3.25
Black Walnut	0.681	42½	3,044	0.65	3.25
Red Cedar	0.665	35	2,525	0.56	2.08
Hard Maple	0.644	40	2,878	0.60	3.00
Soft Maple	0.597	37	2,668	0.54	2.70
Yellow Pine	0.550	34	2,463	0.54	2.70
Butternut	0.567	35½	2,534	0.51	2.55
White Pine	0.418	26	1,866	0.42	2.10
Chestnut	0.552	32	2,333	0.52	2.60

Please Keep These Don'ts in Mind.

Don't call for inspection until you are ready.

Don't use one-fourth bends when it is possible to use one-eighth bends.

Don't put in lead work that is under weight.

Don't fail to put rests where needed.

Don't run vertical lines out of plumb.

Don't add additional fixtures to a job without taking out an additional permit.

Don't refuse to do what the ordinance says shall be done.

Don't make a flat bend in your lead work.

Don't say that your testing plugs won't hold.

Don't cover any work before same has been inspected and approved.

Don't forget to drift kinked pipes.

Don't install cleanouts in places where it is impossible to use them.

Don't try to repair a cracked fitting.

Don't omit cleanouts where the ordinance requires them to be used.

Don't place vent tees lower than the fixtures.

Don't construct work of underweight materials.

Don't forget to ream all wrought iron pipes.

Don't trim wiped joints with a rasp or cold chisel.

Don't give wrong house number when calling for inspection.

Don't forget to put in all water pipes so they will drain.

Don't fail to put up grounds for pipe and fixture supports.

Don't try to calk a joint with a round edged calking iron.

Don't let the marks of the bending spring show on the bend.

Don't let your solder run through to the inside of the pipe.

Don't let the pipe protrude on the inside of a branch joint.

Don't use prohibited fittings in drain, waste or vent pipes.

Don't run vent lines less than two inches in diameter through the roof.

Don't fail to properly support all lead work.

Don't wait until the inspector arrives to fill pipes for testing.

Don't run waste pipes without having the proper pitch.

Don't run vent pipes in such a manner that they may become waste pipes in case of stoppage.

Don't depend on the supply and waste pipes to hold up the fixtures.

Don't forget that traps must be set true to water seal.

Don't expect the inspector to ignore the ordinance because you have done so.

Don't be indifferent about the setting of closet bowls or other fixtures.

Don't forget when you have completed your work to inspect it yourself and thus avoid trouble.

Don't use candle grease, wax or cement on calked joints.

Don't refuse to do what the ordinance says shall be done.

Don't ask the inspector to approve a job if the ground work is not completed.

Don't forget that the soil pipe must extend at least three feet outside of the building.

Don't leave a job without placing a red warning sticker on the work to keep same from being covered over.

Don't fail to test your work from a point three feet outside of the building to the highest vent pipe on the roof.

Don't fail when giving estimates for plumbing to your customers to acquaint them with defects that may exist in the old plumbing and drainage on the premises, for in so doing you may save yourself as well as your customer much future trouble.

Don't forget to consult the plumbing inspector when in doubt about what the ordinance requires.

Don't forget to call for inspection on completed work.

EIGHT HOUR DAY WAGES TABLE—*48* Hours Per Week

$5 83	$5½ 92	$6 100	$6½ 108	$7 117	$7½ 125	$8 133	Per Week Per Day. Hours.	Days	$½ 08	$9 150	$10 167	$10½ 175	$11 183	$12 200	$13 217	$13½ 225	$14 233
05	06	07	07	07	08	08	½		01	09	10	11	11	13	14	14	15
10	11	13	14	15	16	17	1		01	19	21	22	23	25	27	28	29
21	23	25	27	29	31	33	2	¼	02	38	42	44	46	50	54	56	58
31	34	38	41	44	47	50	3		03	56	63	66	69	75	81	84	88
42	46	50	54	58	63	67	4	½	04	75	83	88	92	100	108	113	117
52	57	63	68	73	78	83	5		05	94	104	109	115	125	135	141	146
63	69	75	81	88	94	100	6	¾	06	113	125	131	138	115	0163	169	175
73	80	88	95	102	109	117	7		07	131	146	153	160	175	190	197	204
83	92	100	108	117	125	133	8	1	08	150	167	175	183	200	217	225	233
94	103	113	122	131	141	150	9		09	169	188	197	206	225	244	253	263
104	115	125	135	146	156	167	10	1¼	10	188	208	219	229	250	271	281	292
125	138	150	163	175	188	200	12	1½	13	225	250	263	275	300	325	338	350
167	183	200	217	233	250	267	16	2	17	330	333	350	367	400	433	450	467
208	229	250	271	292	313	333	20	2½	21	375	417	438	458	500	542	563	583
250	275	300	325	350	375	400	24	3	25	450	500	525	550	600	650	675	700
292	321	350	379	408	438	467	28	3½	29	525	583	613	642	700	758	788	817
313	344	375	406	438	469	500	30	3¾	31	563	625	656	688	750	813	844	875
333	367	400	433	467	500	533	32	4	33	600	667	700	733	800	867	900	933
354	390	425	460	496	531	567	34	4¼	35	638	708	744	779	850	921	956	922
375	413	450	488	525	563	600	36	4½	38	675	750	788	825	900	975	1013	1050
396	435	475	515	554	594	633	38	4¾	40	713	792	831	871	950	1029	1069	1108
406	447	488	528	569	609	650	39		41	731	813	853	894	975	1056	1097	1138
417	458	500	542	583	625	667	40	5	42	750	833	875	917	1000	1083	1125	1167
427	470	513	555	598	641	683	41		43	769	854	897	940	1025	1110	1153	1196
438	481	525	569	613	656	700	42	5¼	44	788	875	919	963	1050	1138	1181	1225
448	493	538	582	627	672	717	43		45	806	896	940	985	1075	1165	1209	1254
458	504	550	596	642	688	733	44	5½	46	825	917	963	1008	1100	1192	1238	1283
469	516	563	609	656	703	750	45		47	844	938	984	1031	1125	1219	1266	1313
479	527	575	623	671	719	767	46	5¾	48	863	958	1006	1054	1150	1246	1294	1342
490	539	588	636	685	734	783	47		49	881	979	1028	1077	1175	1273	1322	1371
500	550	600	650	700	750	800	48	6	50	900	$10	1050	1100	1200	1300	1350	1400

$15 250	$16 267	$16½ 275	$17 283	$18 300	$19½ 325	Per Week Per Day Hours.	Days.	$20 333	$21 350	$22 367	$22½ 375	$24 400	$25 417	$27 450	$30 500
16	17	17	18	19	20	½		21	22	23	23	25	26	28	31
31	33	34	35	38	41	1		42	44	46	47	50	52	56	63
63	67	69	71	75	81	2	¼	83	88	92	94	100	104	113	125
94	100	103	106	113	122	3		125	131	138	141	150	156	169	188
125	133	138	142	150	163	4	½	167	175	183	188	200	208	225	250
156	167	172	177	188	203	5		208	219	229	234	250	260	281	313
188	200	206	213	225	244	6	¾	250	263	275	281	300	313	338	375
219	233	241	248	263	284	7		292	306	321	328	350	365	394	438
250	267	275	283	300	325	8	1	333	350	367	375	400	417	450	500
281	300	309	319	338	366	9		375	394	413	422	450	469	506	563
313	333	344	354	375	406	10	1¼	417	438	458	469	500	521	563	625
375	400	413	425	550	488	12	1½	500	525	550	563	600	625	675	750
500	533	550	567	600	650	16	2	667	700	733	750	800	833	900	1000
625	667	688	708	750	813	20	2½	833	875	917	938	1000	1042	1125	1250
750	800	825	850	900	975	24	3	1000	1050	1100	1125	1200	1250	1350	1500
875	933	963	992	1050	1138	28	3½	1167	1225	1283	1313	1400	1458	1575	1750
938	1000	1031	1063	1125	1219	30	3¾	1250	1313	1375	1406	1500	1563	1688	1875
1000	1067	1100	1133	1200	1300	32	4	1333	1400	1467	1500	1600	1667	1800	2000
1063	1133	1169	1204	1275	1381	34	4¼	1417	1488	1558	1594	1700	1771	1913	2125
1125	1200	1238	1275	1350	1463	36	4½	1500	1575	1650	1688	1800	1875	2025	2250
1188	1267	1306	1346	1425	1544	38	4¾	1583	1663	1742	1781	1900	1979	2138	2375
1219	1300	1341	1381	1463	1584	39		1625	1706	1788	1828	1950	2031	2194	2438
1250	1333	1375	1417	1500	1625	40	5	1667	1750	1833	1875	2000	2083	2250	2500
1281	1367	1409	1452	1538	1666	41		1708	1794	1879	1922	2050	2135	2306	2563
1313	1400	1444	1488	1575	1706	42	5¼	1750	1838	1925	1969	2100	2188	2363	2625
1344	1433	1478	1523	1616	1747	43		1792	1881	1971	2016	2150	2240	2419	2688
1375	1467	1513	1558	1650	1788	44	5½	1833	1925	2017	2063	2200	2292	2475	2750
1406	1500	1547	1594	1688	1828	45		1875	1969	2063	2109	2250	2344	2531	2813
1438	1533	1581	1629	1725	1869	46	5¾	1917	2013	2108	2156	2300	2396	2588	2875
1469	1567	1616	1665	1763	1909	47		1958	2056	2154	2203	2350	2448	2644	2938
1500	1600	1650	1700	1800	1950	48	6	2000	2100	2200	2250	2400	2500	2700	3000

At $9 per Week ($1.50 per Day), the Wages for 46 Hours (5¾ Days) amount to $8.63.

TABLE showing EQUIVALENT of several Discounts; Proceeds on $; Profit on Cost.

A	B	C	D	E	A	B	C	D	E
1 %	And 0 % off	= 1 % off	99	1 01	**60** %	And 0 % off	=60 % off	40	150
2 "	0 "	= 2 "	98	2 04	60 "	2½ "	=61 "	39	156 41
3 "	0 "	= 3 "	97	3 09	60 "	5 "	=62 "	38	163 16
4 "	0 "	= 4 "	96	4 17	60 "	7½ "	=63 "	37	170 27
5 "	0 "	= 5 "	95	5 26	60 "	10 "	=64 "	36	177 78
6 "	0 "	= 6 "	94	6 38	60 "	12½ "	=65 "	35	185 71
7 "	0 "	= 7 "	93	7 53	60 "	15 "	=66 "	34	194 12
8 "	0 "	= 8 "	92	8 70	60 "	17½ "	=67 "	33	203 03
10 "	**0** "	=10 "	90	11 11	60 "	20 "	=68 "	32	212 50
10 "	2½ "	=12¼ "	87¾	13 96	60 "	22½ "	=69 "	31	222 58
10 "	5 "	=14½ "	85½	16 96	**60** "	25 "	=70 "	30	233 33
12½ "	**0** "	=12½ "	87½	14 29	60 "	27½ "	=71 "	29	244 83
12½ "	2½ "	=14⅔ "	85⅓	*17 19	60 "	30 "	=72 "	28	257 14
12½ "	5 "	=16⅞ "	83⅛	20 30 "	60 "	33⅓ "	=73⅓ "	26	275
15 "	**0** "	=15 "	85	17 65 "	60 "	35 "	=74 "	26⅔	284 62
15 "	2½ "	=17⅛ "	82⅞	20 66 "	60 "	37½ "	=75 "	25	300
15 "	5 "	=19¼ "	80¾	23 84 "	60 "	40 "	=76 "	24	316 67
15 "	10 "	=23½ "	76½	30 72 "	60 "	42½ "	=77 "	23	334 78
16⅔ "	**0** "	=16⅔ "	83⅓	20 "	60 "	45 "	=78 "	22	354 55
16⅔ "	2½ "	=18¾ "	81¼	23 08 "	60 "	47½ "	=79 "	21	376 19
16⅔ "	5 "	=20⅚ "	79⅙	26 32 "	60 "	50 "	=80 "	20	400
16⅔ "	10 "	=25 "	75	33 33 "	**66⅔** "	**0** "	=66⅔ "	33⅓	200
20 "	**0** "	=20 "	80	25 "	66⅔ "	5 "	=68⅓ "	31⅓	215 79
20 "	2½ "	=22 "	78	28 21 "	66⅔ "	10 "	=70 "	30	233 33
20 "	5 "	=24 "	76	31 58 "	66⅔ "	20 "	=73⅓ "	26⅔	275
20 "	10 "	=28 "	72	38 89 "	66⅔ "	25 "	=75 "	25	300
20 "	15 "	=32 "	68	47 06 "	66⅔ "	33⅓ "	=77 7/9 "	22 2/9	350
25 "	**0** "	=25 "	75	33 33 "	66⅔ "	40 "	=80 "	20	400
25 "	2½ "	=26⅞ "	73⅛	36 75 "	66⅔ "	50 "	=83⅓ "	16⅔	500
25 "	5 "	=28¾ "	71¼	40 35 "	**70** "	**0** "	=70 "	30	233 33
25 "	10 "	=32½ "	67½	48 15 "	70 "	5 "	=71½ "	28½	250 88
25 "	20 "	=40 "	60	66 67 "	70 "	10 "	=73 "	27	270 37
30 "	**0** "	=30 "	70	42 86 "	70 "	20 "	=76 "	24	316 67
30 "	2½ "	=31¾ "	68¼	46 52 "	70 "	25 "	=77½ "	22½	344 44
30 "	5 "	=33½ "	66½	50 38 "	70 "	30 "	=79 "	21	376 19
30 "	10 "	=37 "	63	58 73 "	70 "	33⅓ "	=80 "	20	400
30 "	20 "	=44 "	56	78 57 "	70 "	40 "	=82 "	18	455 56
33⅓ "	**0** "	=33⅓ "	66⅔	50 "	70 "	50 "	=85 "	15	566 67
33⅓ "	2½ "	=35 "	65	53 85 "	**75** "	**0** "	=75 "	25	300
33⅓ "	5 "	=36⅔ "	63⅓	57 89 "	75 "	5 "	=76¼ "	23¾	321 05
33⅓ "	10 "	=40 "	60	66 67 "	75 "	10 "	=77½ "	22½	344 44
33⅓ "	20 "	=46⅔ "	53⅓	87 50 "	75 "	20 "	=80 "	20	400
33⅓ "	25 "	=50 "	50	100 "	75 "	25 "	=81¼ "	18¾	433 33
35 "	0 "	=35 "	65	53 85 "	75 "	30 "	=82½ "	17½	471 43
37½ "	0 "	=37½ "	62½	60 "	75 "	33⅓ "	=83⅓ "	16⅔	500
40 "	**0** "	=40 "	60	66 67 "	75 "	40 "	=85 "	15	566 67
40 "	2½ "	=41½ "	58½	70 94 "	75 "	50 "	=87½ "	12½	700
40 "	5 "	=43 "	57	75 44 "	**80** "	**0** "	=80 "	20	400
40 "	10 "	=46 "	54	85 19 "	80 "	5 "	=81 "	19	426 32
40 "	15 "	=49 "	51	96 08 "	80 "	10 "	=82 "	18	455 56
40 "	20 "	=52 "	48	108 33 "	80 "	20 "	=84 "	16	525
40 "	25 "	=55 "	45	122 22 "	80 "	25 "	=85 "	15	566 67
40 "	30 "	=58 "	42	138 10 "	80 "	30 "	=86 "	14	614 29
40 "	33⅓ "	=60 "	40	150 "	80 "	40 "	=88 "	12	733 33
45 "	0 "	=45 "	55	81 82 "	80 "	50 "	=90 "	10	900
40 "	**0** "	=50 "	50	100 "	80 "	60 "	=92 "	08	1150
50 "	2½ "	=51¼ "	48¾	105 13 "	**90** "	**0** "	=90 "	10	900
50 "	5 "	=52½ "	47½	110 53 "	90 "	10 "	=91 "	09	1011 11
50 "	10 "	=55 "	45	122 22 "	90 "	20 "	=92 "	08	1150
50 "	15 "	=57½ "	42½	135 29 "	90 "	30 "	=93 "	07	1328 57
50 "	20 "	=60 "	40	150 "	90 "	40 "	=94 "	06	1566 67
50 "	25 "	=62½ "	37½	166 67 "	90 "	50 "	=95 "	05	1900
50 "	30 "	=65 "	35	185 71 "	90 "	60 "	=96 "	04	2400
50 "	33⅓ "	=66⅔ "	33⅓	200 "	90 "	70 "	=97 "	03	3233 33
50 "	40 "	=70 "	30	233 33 "	90 "	80 "	=98 "	02	4900
55 "	0 "	=55 "	45	122 22 "	90 "	90 "	=99 "	01	9900

Col. D: Cents on the Dollar. Col. E: Per Cent Profit (see last col.)

Col. E, shows the % made on Cost, when goods are bought at one or more Discounts from List price, and sold **at List price**. D, shows No. of Cents paid on $.

The **whole** Discount is shown in Col. C, when **two** (A and B) are given. Thus 40.% off (A) and 10% off remainder (B), = **46**% off (C); which = 54c on the $ (D,)&c (See Art. 194). The Rules and Principles of Trade Discount are clearly set forth in Arts. 190 to 199.

TABLE Aiding DEALERS, MANUFACTURERS—Fixing Prices, Profits, Discounts.

For Retail Trade			For Wholesale Trade			Manufacturers, Jobbers		
If you Add to Cost Price	And deduct off Retail Price	Profit on Cost will be	If you Buy (of List) at	And Sell (same List) at	Profit on Cost will be	In order to give Trade	And realize on Cost	List Price must be (Times the Cost.)
10 %	2 1/2%	7 1/4%	10%off	2 1/2%off	8 1/3 %	10%off	10 %	1 2/9
10 "	5 "	4 1/2"	10 "	5 "	5 5/9"	10 "	20 "	1 1/3
12 1/2"	5 "	6 7/8"	12 1/2"	5 "	8 4/7"	12 1/2"	20 "	*1 3/8
15 "	5 "	9 1/4"	15 "	5 "	*11 3/4"	15 "	20 "	*1 5/8
16 2/3"	5 "	10 5/6"	16 2/3"	5 "	14 3/4"	16 2/3"	20 "	*1 4/9
20 "	2 1/2"	17 "	20 "	5 "	18 3/4"	20 "	20 "	1 1/2
20 "	5 "	14 "	20 "	10 "	12 1/2"	20 "	30 "	1 5/8
20 "	10 "	8 "	20 "	12 1/2 "	9 3/8"	20 "	40 "	1 3/4
20 "	12 1/2"	5 "	20 "	15 "	6 1/4"	20 "	50 "	1 7/8
25 "	2 1/2"	21 7/8	25 "	5 "	26 2/3"	25 "	20 "	1 3/5"
25 "	5 "	18 3/4"	25 "	10 "	20 "	25 "	30 "	*1 3/4"
25 "	10 "	12 1/2"	25 "	15 "	13 1/3"	25 "	40 "	*1 7/8"
25 "	15 "	6 1/4"	25 "	20 "	6 2/3"	25 "	50 "	2 "
30 "	2 1/2"	26 3/4"	30 "	10 "	28 4/7"	30 "	20 "	1 5/7"
30 "	5 "	23 1/2"	30 "	15 "	21 3/7"	30 "	30 "	1 6/7"
30 "	10 "	17 "	30 "	20 "	14 2/7"	30 "	40 "	2 "
30 "	15 "	10 1/2"	30 "	25 "	7 1/7"	30 "	50 "	2 1/7"
33 1/3"	2 1/2"	30 "	33 1/3"	10 "	35 "	33 1/3"	20 "	1 4/5"
33 1/3"	5 "	26 2/3"	33 1/3"	15 "	27 1/2"	33 1/3"	33 1/3"	2 "
33 1/3"	10 "	20 "	33 1/3"	20 "	20 "	33 1/3"	40 "	2 1/10"
33 1/3"	15 "	13 1/3"	33 1/3"	25 "	12 1/2"	33 1/3"	50 "	2 1/4"
33 1/3"	20 "	6 2/3"	33 1/3"	30 "	5 "	33 1/3"	60 "	2 2/5"
40 "	2 1/2"	36 1/2"	40 "	10 "	50 "	40 "	20 "	2 "
40 "	5 "	33 "	40 "	15 "	41 2/3"	40 "	30 "	2 1/6"
40 "	10 "	26 "	40 "	20 "	33 1/3"	40 "	40 "	2 1/3"
40 "	15 "	19 "	40 "	25 "	25 "	40 "	50 "	2 1/2"
40 "	20 "	12 "	40 "	30 "	16 2/3"	40 "	60 "	2 2/3"
40 "	25 "	5 "	40 "	33 1/3 "	11 1/9"	40 "	80 "	3 "
50 "	5 "	42 1/2"	50 "	10 "	80 "	50 "	33 1/3"	2 8/3"
50 "	10 "	35 "	50 "	20 "	60 "	50 "	40 "	2 4/5"
50 "	15 "	27 1/2"	50 "	25 "	50 "	50 "	50 "	3 "
50 "	20 "	20 "	50 "	30 "	40 "	50 "	60 "	3 1/5"
50 "	25 "	12 1/2"	50 "	33 1/3 "	33 1/3"	50 "	80 "	3 3/5"
50 "	30 "	5 "	50 "	40 "	20 "	50 "	100 "	4 "
60 "	5 "	52 "	60 "	20 "	100 "	60 "	33 1/3"	3 1/3"
60 "	10 "	44 "	60 "	25 "	87 1/2"	60 "	40 "	3 1/2"
60 "	15 "	36 "	60 "	30 "	75 "	60 "	50 "	3 3/4"
60 "	20 "	28 "	60 "	33 1/3 "	66 2/3"	60 "	60 "	4 "
60 "	25 "	20 "	60 "	40 "	50 "	60 "	70 "	4 1/4"
60 "	30 "	12 "	60 "	45 "	37 1/2"	60 "	80 "	4 1/2"
60 "	33 1/3"	6 2/3"	60 "	50 "	25 "	60 "	100 "	5 "
66 2/3"	10 "	50 "	66 2/3"	20 "	140 "	66 2/3"	33 1/3"	4 "
66 2/3"	15 "	41 2/3"	66 2/3"	25 "	125 "	66 2/3"	40 "	4 1/5"
66 2/3"	20 "	33 1/3"	66 2/3"	33 1/3 "	100 "	66 2/3"	50 "	4 1/2"
66 2/3"	25 "	25 "	66 2/3"	40 "	80 "	66 2/3"	60 "	4 4/5"
66 2/3"	30 "	16 2/3"	66 2/3"	50 "	50 "	66 2/3"	80 "	5 2/5"
66 2/3"	33 1/3"	11 1/9"	66 2/3"	60 "	20 "	66 2/3"	100 "	6 "
70 "	10 "	53 "	70 "	25 "	150 "	70 "	33 1/3"	4 4/9"
70 "	15 "	44 1/2"	70 "	30 "	133 1/3"	70 "	40 "	4 2/3"
70 "	20 "	36 "	70 "	33 1/3 "	122 2/9"	70 "	50 "	5 "
70 "	25 "	27 1/2"	70 "	40 "	100 "	70 "	60 "	5 1/3"
70 "	30 "	19 "	70 "	50 "	66 2/3"	70 "	80 "	6 "
70 "	33 1/3"	13 1/3"	70 "	60 "	33 1/3"	70 "	100 "	6 2/3"
75 "	10 "	57 1/2"	75 "	30 "	180 "	75 "	33 1/3"	5 1/3"
75 "	15 "	48 3/4"	75 "	40 "	140 "	75 "	40 "	5 3/5"
75 "	20 "	40 "	75 "	50 "	100 "	75 "	50 "	6 "
75 "	25 "	31 1/4"	75 "	60 "	60 "	75 "	60 "	6 2/5"
75 "	30 "	22 1/2"	75 "	66 2/3 "	33 1/3"	75 "	80 "	7 1/5"
75 "	33 1/3"	16 2/3"	75 "	70 "	20 "	75 "	100 "	8 "
80 "	10 "	62 "	80 "	30 "	250 "	80 "	33 1/3"	6 2/3"
80 "	15 "	53 "	80 "	40 "	200 "	80 "	40 "	7 "
80 "	20 "	44 "	80 "	50 "	150 "	80 "	50 "	7 1/2"
80 "	25 "	35 "	80 "	60 "	100 "	80 "	60 "	8 "
80 "	30 "	26 "	80 "	70 "	50 "	80 "	80 "	9 "
80 "	33 1/3"	20 "	80 "	75 "	25 "	80 "	100 "	10 "

(A). If you mark goods to make 40% profit (col.1), then sell at a discount of 20% from marking price (c.2), your profit will be 12% on cost (c.3). (Art. 195).

(B). If you buy at 50% off (col. 1), and sell to the Trade or Agents at 40% off same List (col.2), your profit will be 20% on cost (col.3) (See Rule, Art. 196).

(C.) In order to give the Trade or Agents 50% off (col. 1), and still make 100% profit on the cost (c.2), the **List** price must be **4 times the cost** (c.3). (Art. 197).

These Tables will save Buyers and Sellers many abstruse Calculations.

PERPETUAL CALENDAR

GOOD FOR THREE CENTURIES

1800	1801	1802	1803	....	**1804**	1805
1806	1807	....	**1808**	1809	1810	1811
....	**1812**	1813	1814	1815	....	**1816**
1817	1818	1819	....	**1820**	1821	1822
1823	....	**1824**	1825	1826	1827	....
1828	1829	1830	1831	....	**1832**	1833
1834	1835	....	**1836**	1837	1838	1839
....	**1840**	1841	1842	1843	....	**1844**
1845	1846	1847	....	**1848**	1849	1850
1851	....	**1852**	1853	1854	1855	....
1856	1857	1858	1859	....	**1860**	1861
1862	1863	....	**1864**	1865	1866	1867
....	**1868**	1869	1870	1871	....	**1872**
1873	1874	1875	....	**1876**	1877	1878
1879	....	**1880**	1881	1882	1883	....
1884	1885	1886	1887	....	**1888**	1889
1890	1891	....	**1892**	1893	1894	1895
....	**1896**	1897	1898	1899	1900	1901
1902	1903	....	**1904**	1905	1906	1907
....	**1908**	1909	1910	1911	....	**1912**
1913	1914	1915	....	**1916**	1917	1918
1919	....	**1920**	1921	1922	1923	....
1924	1925	1926	1927	....	**1928**	1929
1930	1931	....	**1932**	1933	1934	1935
....	**1936**	1937	1938	1939	....	**1940**
JA **3** ^{2}	JA **4** ^{3}	JA **5** ^{4}	JA **6** ^{5}	JA **7** ^{6}	JA **1** ^{7}	JA **2** ^{1}
FE **6** ^{5}	FE **7** ^{6}	FE **1** ^{7}	FE **2** ^{1}	FE **3** ^{2}	FE **4** ^{3}	FE **5** ^{4}
MA **6**	MA **7**	MA **1**	MA **2**	MA **3**	MA **4**	MA **5**
AP **2**	AP **3**	AP **4**	AP **5**	AP **6**	AP **7**	AP **1**
MY **4**	MY **5**	MY **6**	MY **7**	MY **1**	MY **2**	MY **3**
JU **7**	JU **1**	JU **2**	JU **3**	JU **4**	JU **5**	JU **6**
JY **2**	JY **3**	JY **4**	JY **5**	JY **6**	JY **7**	JY **1**
AU **5**	AU **6**	AU **7**	AU **1**	AU **2**	AU **3**	AU **4**
SE **1**	SE **2**	SE **3**	SE **4**	SE **5**	SE **6**	SE **7**
OC **3**	OC **4**	OC **5**	OC **6**	OC **7**	OC **1**	OC **2**
NO **6**	NO **7**	NO **1**	NO **2**	NO **3**	NO **4**	NO **5**
DE **1**	DE **2**	DE **3**	DE **4**	DE **5**	DE **6**	DE **7**

1st Clndr	2nd Clndr	3rd Clndr	4th Clndr	5th Clndr	6th Clndr	7th Clndr
1 Mo	1 Tu	1 We	1 Th	1 Fr	1 Sa	1 **Su**
2 Tu	2 We	2 Th	2 Fr	2 Sa	2 **Su**	2 Mo
3 We	3 Th	3 Fr	3 Sa	3 **Su**	3 Mo	3 Tu
4 Th	4 Fr	4 Sa	4 **Su**	4 Mo	4 Tu	4 We
5 Fr	5 Sa	5 **Su**	5 Mo	5 Tu	5 We	5 Th
6 Sa	6 **Su**	6 Mo	6 Tu	6 We	6 Th	6 Fr
7 **Su**	7 Mo	7 Tu	7 We	7 Tu	7 Fr	7 Sa
8 Mo	8 Tu	8 We	8 Th	8 Fr	8 Sa	8 **Su**
9 Tu	9 We	9 Th	9 Fr	9 Sa	9 **Su**	9 Mo
10 We	10 Th	10 Fr	10 Sa	10 **Su**	10 Mo	10 Tu
11 Th	11 Fr	11 Sa	11 **Su**	11 Mo	11 Tu	11 We
12 Fr	12 Sa	12 **Su**	12 Mo	12 Tu	12 We	12 Th
13 Sa	13 **Su**	13 Mo	13 Tu	13 We	13 Th	13 Fr
14 **Su**	14 Mo	14 Tu	14 We	14 Th	14 Fr	14 Sa
15 Mo	15 Tu	15 We	15 Th	15 Fr	15 Sa	15 **Su**
16 Tu	16 We	16 Th	16 Fr	16 Sa	16 **Su**	16 Mo
17 We	17 Th	17 Fr	17 Sa	17 **Su**	17 Mo	17 Tu
18 Th	18 Fr	18 Sa	18 **Su**	18 Mo	18 Tu	18 We
19 Fr	19 Sa	19 **Su**	19 Mo	19 Tu	19 We	19 Th
20 Sa	20 **Su**	20 Mo	20 Tu	20 We	20 Th	20 Fr
21 **Su**	21 Mo	21 Tu	21 We	21 Th	21 Fr	21 Sa
22 Mo	22 Tu	22 We	22 Th	22 Fr	22 Sa	22 **Su**
23 Tu	23 We	23 Th	23 Fr	23 Sa	23 **Su**	23 Mo
24 We	24 Th	24 Fr	24 Sa	24 **Su**	24 Mo	24 Tu
25 Th	25 Fr	25 Sa	25 **Su**	25 Mo	25 Tu	25 We
26 Fr	26 Sa	26 **Su**	26 Mo	26 Tu	26 We	26 Th
27 Sa	27 **Su**	27 Mo	27 Tu	27 We	27 Th	27 Fr
28 **Su**	28 Mo	28 Tu	28 We	28 Th	28 Fr	28 Sa
29 Mo	29 Tu	29 We	29 Th	29 Fr	29 Sa	29 **Su**
30 Tu	30 We	30 Th	30 Fr	30 Sa	30 **Su**	30 Mo
31 We	31 Th	31 Fr	31 Sa	31 **Su**	31 Mo	31 Tu

For Finding the
Day of the Week for
Any Date from 1800 to 1940.

To find the right Calendar—for July 1876, for instance; **look for 1876, run down that column to July, the figure 6 there refers to the 6th Calendar,** which shows that the 1st of July 1876 occurred on Saturday; the 4th on Tuesday, &c.

Note—In **Leap Years,** use the **small** figures for **Jan. and Feb.**

For any Date in the 18th Century, shift **two** days forward; and for the 20th, **two** days backward from the corresponding Day in the 19th. Thus, we find that in 1876, July 4, occurred on Tues.; hence. in **1776**, it must have occurred on Thurs.—**two** days forward from Tues.; and in **1976**, it will fall on Sun.—**two** days backward from Tues. (Art. 360.)

It is quite interesting to know on what Day births, deaths and other notable events occurred.

On what Day were **You** born?

The **Table** on the right shows on what Day of the month, in Mar., or Apr., **Easter Sundays** fall from the year 1801 to 1950.

The Council of Nice, in A. D., 325, decreed that **Easter** should be celebrated, always on the first Sunday after the Full Moon next after the Spring Equinox. Hence, Easter can come as early as March 22, as in 1818; and as late as April 25, as in 1886.

EASTER SUNDAYS

1801	A 5	1851	A 20	1901	A 7
1802	A 18	1852	A 11	1902	M30
1803	A 10	1853	M27	1903	A 12
1804	A 1	1854	A 16	1904	A 3
1805	A 14	1855	A 8	1905	A 23
1806	A 6	1856	M23	1906	A 15
1807	M29	1857	A 12	1907	M31
1808	A 17	1858	A 4	1908	A 19
1809	A 2	1859	A 24	1909	A 11
1810	A 22	1860	A 8	1910	M27
1811	A 14	1861	M31	1911	A 16
1812	M29	1862	A 20	1912	A 7
1813	A 18	1863	A 5	1913	M23
1814	A 10	1864	M27	1914	A 12
1815	M26	1865	A 16	1915	A 4
1816	A 14	1866	A 1	1916	A 23
1817	A 6	1867	A 21	1917	A 8
1818	M22	1868	A 12	1918	M31
1819	A 11	1869	M28	1919	A 20
1820	A 2	1870	A 17	1920	A 4
1821	A 22	1871	A 9	1921	M27
1822	A 7	1872	M31	1922	A 16
1823	M30	1873	A 13	1923	A 1
1824	A 18	1874	A 5	1924	A 20
1825	A 3	1875	M28	1925	A 12
1826	M26	1876	A 16	1926	A 4
1827	A 15	1877	A 1	1927	A 17
1828	A 6	1878	A 21	1928	A 8
1829	A 19	1879	A 13	1929	M31
1830	A 11	1880	M28	1930	A 20
1831	A 3	1881	A 17	1931	A 6
1832	A 22	1882	A 9	1932	M27
1833	A 7	1883	M25	1933	A 16
1834	M30	1884	A 13	1934	A 1
1835	A 19	1885	A 5	1935	A 21
1836	A 3	1886	A 25	1936	A 12
1837	M26	1887	A 10	1937	M28
1838	A 15	1888	A 1	1938	A 17
1839	M31	1889	A 21	1939	A 9
1840	A 19	1890	A 6	1940	M24
1841	A 11	1891	M29	1941	A 13
1842	M27	1892	A 17	1942	A 6
1843	A 16	1893	A 2	1943	A 25
1844	A 7	1894	M25	1944	A 9
1845	M23	1895	A 14	1945	A 1
1845	A 12	1896	A 5	1946	A 21
1847	A 4	1897	A 18	1947	A 6
1848	A 23	1898	A 10	1948	M28
1849	A 8	1899	A 2	1949	A 17
1850	M31	1900	A 15	1950	A [illegible]

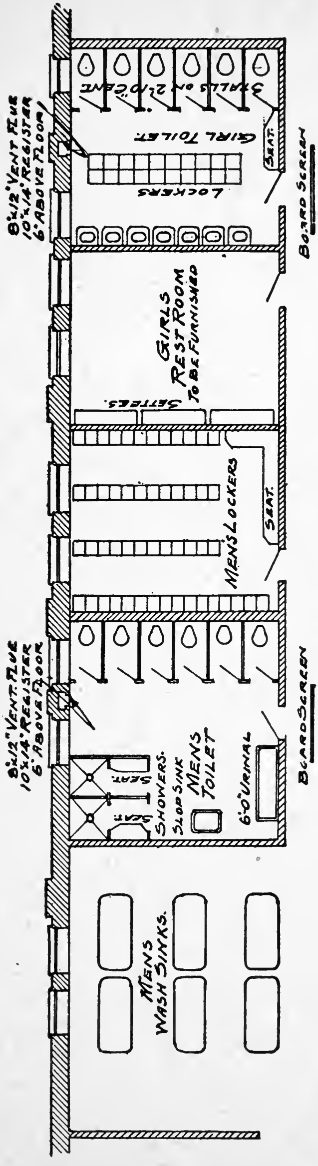
Modern Factory Toilet Systems

The sanitary arrangements and toliet facilities of a modern up-to-date factory are entirely different from what they were ten years ago. At that time all that was expected for the comfort and cleanliness of the help were a couple of wooden or, perhaps, black cast iron troughs with a steam coil in the trough to temper the cold water. Here in the same water, a dozen or more had to wash. As for water closets, two or three were considered sufficient even for a force of a hundred men. Showers were things unheard of.

In a modern factory you will find as a rule, 30"-x6'-0" enameled wash sinks with six combination hot and cold water faucets to each sink, and the men wash their hands and faces in water coming directly from the faucets. For the women it is customary to arrange individual enameled cast iron lavatories with combination hot and cold water faucets.

As a rule water closets in up-to-date factories are installed to a number corresponding with one closet for every 15 to 20 persons. Another great improvement is that nearly all new factories now have a good sized rest room for the women help in which are settees, chairs, tables, and in most cases, a cot, to be used if someone suddenly becomes ill. There is also a first aid set. Ventilated steel lockers 12"-x12"x5'-0" high for men and 15"x15"x5'-0" high for women are also installed.

The accompanying drawing shows a very complete arrangement of toilet, locker and rest rooms and will give the reader a very clear idea of how toilets, etc. are arranged by modern up-to-date industrial engineers.


8"x12" Vent Flue
10"x14" Register
6' Above Floor
Stalls on 2'-10" Cent.
Girl Toilet
Seat.
Lockers
Board Screen
Girls
Rest Room
To Be Furnished
Settees.
Seat.
Men's Lockers
8"x12" Vent. Flue
10"x14" Register
6' Above Floor
Board Screen
Seat.
Showers.
Slop Sink
Seat.
Mens
Toilet
6'-0" Urinal
Mens
Wash Sinks.

Rapid Circulation of Hot Water.

A simple manner of illustrating friction in the flow of water through pipes at various angles is shown in the accompanying illustration, which represents 5 pipes standing on end. If we drop a marble into each pipe, and take notice of the time that it takes the marble to travel through each pipe we will find that the marble dropped into the sraight pipe will reach the botton in the shortest time. The marble dropped into the quarter bend pipe, Fig. 5, will require the longest time. If these pipes were of glass we would notice—we will say for illustrating it—that the marble dropped into the straight pipe, marked Fig. 1, would travel through this straight and perpendicular pipe without touching the wall of the pipe—as shown by arrows in illustration—consequently no friction. In Figure Fig. 2 it would drop at a great velocity through the straight part, which is about ⅔ of the whole length of the pipe, but as soon as it reaches the bent part it would roll on the wall of the pipe, causing a friction which would retard its motion. In Figure 3 the straight and perpendicular part of the pipe is less than in Fig. 2 and in Fig. 4 it is less than in Fig. 3, therefore the marble will be under frictional contact of the pipe for a longer time in Fig. 3 than it is in Fig. 2, and in Fig. 4 far more than it is in Fig. 3. Fig. 5 being a quarter bend, the marble will come in contact with the pipe from the very starting point. Consequently be under friction through its whole journey through the pipe, and requiring the longest time to pass through it. This might represent an elbow in a hot water heating plant. Short Elbows and Bends, therefore, for such work are great obstacles to rapid movement of water in any heating apparatus. Long Bends should be used where angles are necessary, in branches as well as in elbows.

Rapid Circulation of Hot Water

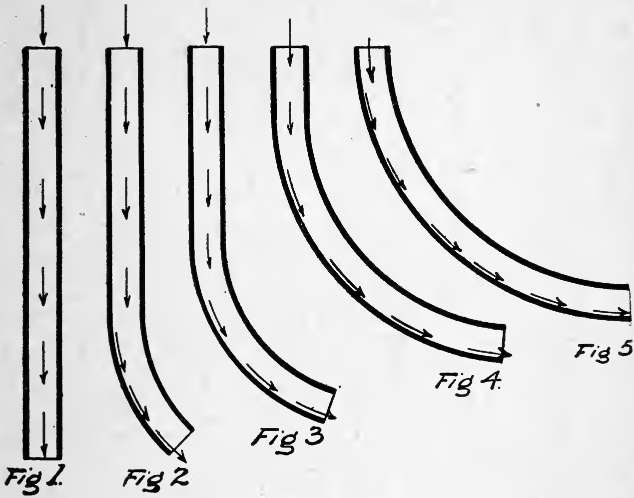


Fig. B.

Sewage.

Sewage is composed of waste water carrying in suspension organic and inorganic wastes. The organic wastes contain both animal and vegetable matter, such as urine and excreta and wastes from kitchen sinks, slaughtering, rendering and packing establishments, etc. Inorganic wastes are from manufacturing establishments, as for instance paper mills, foundries, gasworks and tar or asphalt plants. The decomposition of the organic wastes produces menthane or marsh gas according to the best authorities.

This is a poisonous gas, but not so virulent as carbon-monoxide, which is a deadly poison, producing almost instant death.

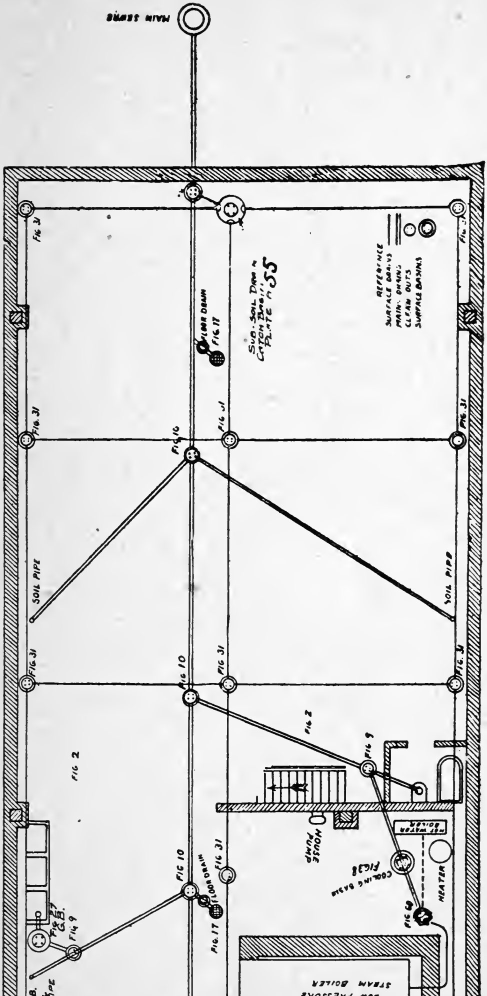
Carbon monoxide and carbon dioxide gases are probably produced in sewage by inorganic wastes. Invariably it will be found that the presence of such gases in public sewers carrying sewage is due to leaks in gas mains.

All brick sewers are porous, nearly all tile sewers leak at points where connections have been made and thereby absorb the leaking gas from mains. Such gases are poisonous and cause many of the fatal accidents which sometimes happen in sewer manholes, catch basins and excavations. These gases must be kept out of houses for the same reason, hence we have traps, vents, etc., in our modern plumbing systems.

The treatment of raw sewage by means of septic tanks and filter beds, or by dilution, renders it harmless.

The action of animalculæ in septic tanks is being studied by engineers and chemists to the end that sanitary disposal of sewage may be accomplished in a manner suitable to inland towns.

The dilution method of disposal is more suitable to towns and cities on tide water or on large rivers, provided the volume of water in the rivers is sufficient and other towns do not use such water for domestic purposes.



Drainage System No. 104

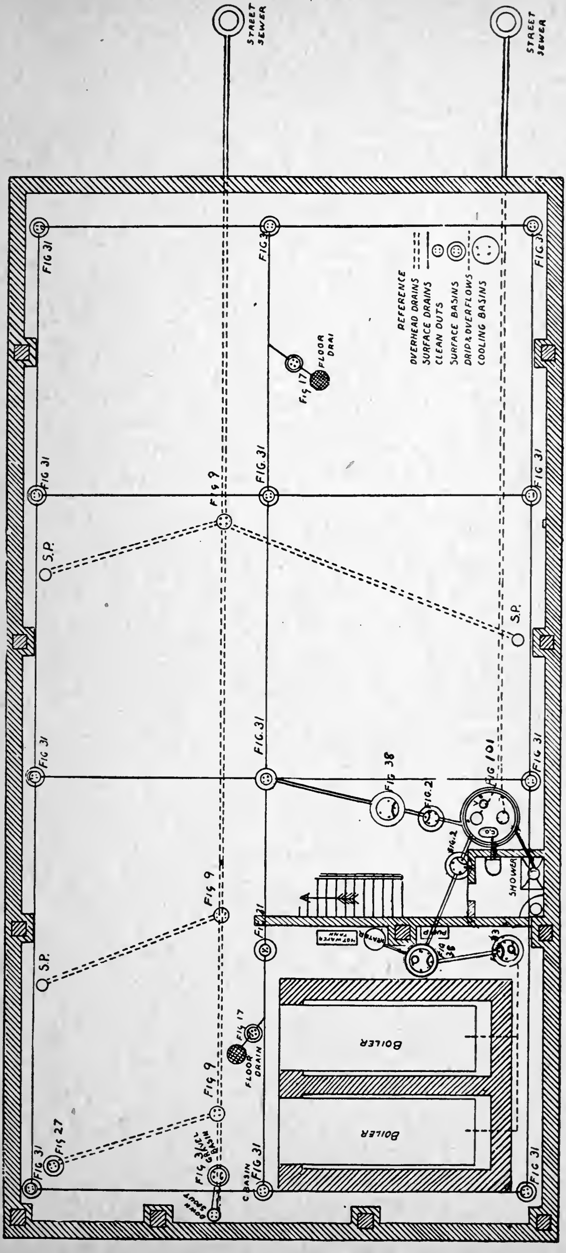
Drainage Plan, Fig. 104.

A gravity system for sewage and subsoil waters flowing directly to public sewer. Clean-out Y branch fittings, Fig. 10, back water gate valves, Fig. 2, subsoil drain basin, Fig. 31, and water jacket grease basin, Fig. 27 or Fig. 29, for receiving waste from sinks are used as indicated on plans. Also gravel basin, Fig. 31, is shown near rear wall to which down spouts may be attached.

Plans, Figs. 102, 103 and 104, give an idea where best to install Wade clean-out fittings, back water gate valves, catch basins, bilge pumping outfit, etc. In connection with lines of sewer and sub-soil drains. Each accessible flushing clean-out back water gate valve and clean-out fitting is provided with an iron inspection manhole which reaches from the sewer in the ground to the surface of cellar floor and is also provided with a tight iron cover which is easily removed when necessary and permits direct access to the back water gate valves, clean-out fittings and interior of house drains without removing any floors or concrete. The Wade accessible sewer flushing clean-out system, back water gate valves, catch basins and bilge pumping outfit as shown and illustrated in this book guarantee cleanliness in the house drains, accessibility for inspection and easiness by which they can be flushed and cleaned. They give knowledge to the owner or occupant of the building of the exact location and condition of the sewer and access to the straight lines of drains and lateral branches and obviate the danger of clogged sewers, flooded basements and sewer gas. If, therefore, you are erecting new or remodeling old residences or business structures, install Wade Accessible House Drainage Systems—since correct house drains prevent disease, preserve **life, health** and **welfare of humanity.**

Drainage Plan, Fig. 103.

Consists of an extra heavy cast iron pipe, as shown in double dotted lines, hung from the basement ceiling. By gravity it discharges direct to the public sewer. Gravel basin, Fig. 31 or Fig. 49½, is shown near rear wall to which down spout is connected. Sink grease basin, Fig. 27 or Fig. 29, is also shown on plan and is intended for use at the foot of sink waste pipe. The above system embraces all pipes leading from fixtures located above the basement.



Drainage System—No. 103

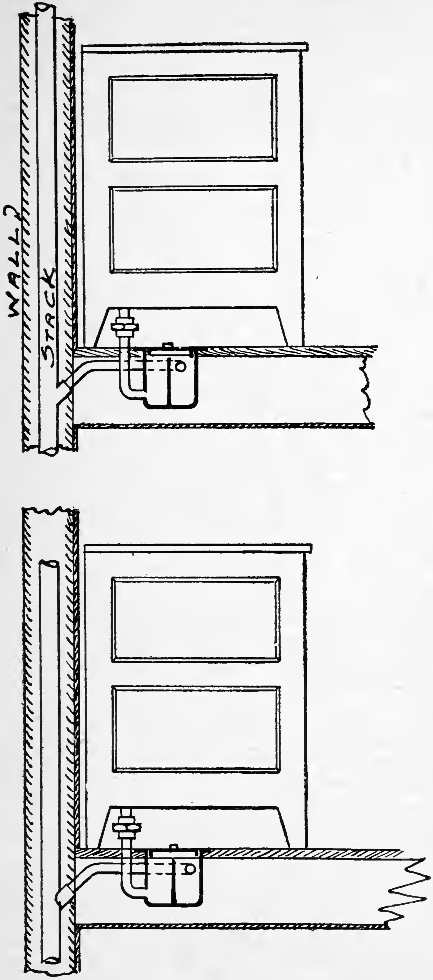
Ice Box.

A great deal of attention has of late been given to the sanitary connection of the waste from a refrigerator to the soil pipe. This is especially true when planning for two, three or more stories apartment buildings where the refrigerators on the different floors are located directly over one another.

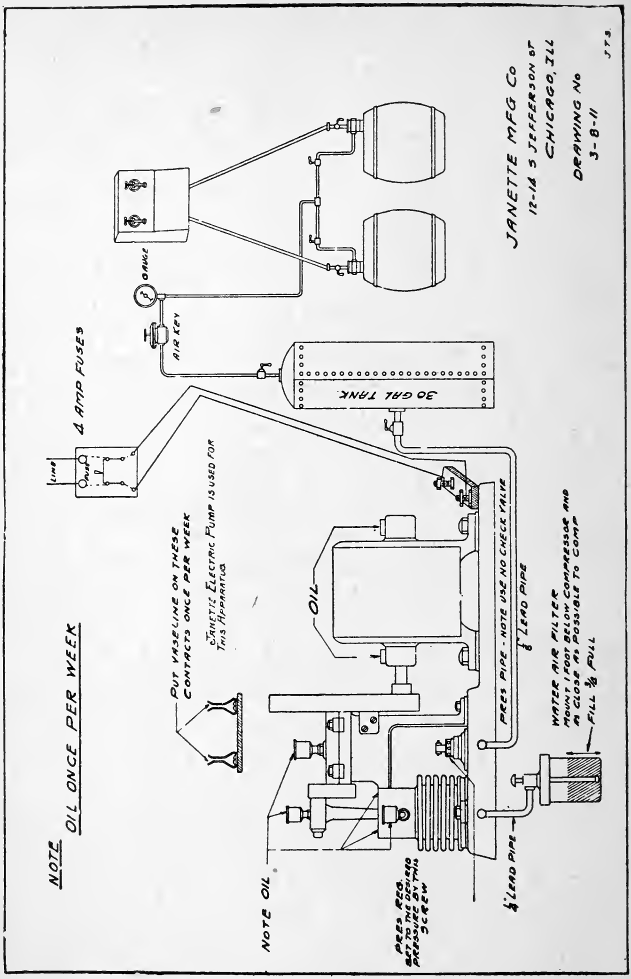
The drawing on the following page shows the latest connection of two refrigerators. Here a special drum trap is located under the floor. The trap is connected to the waste by means of a union. By simply disconnecting this union, the refrigerator can easily be moved. The traps should be from 6 to 8 inches in diameter and 8 inches deep.

In the center of the trap is a partition wall dividing it in two parts. This partition extends to within two inches of the top. Waste is connected to the bottom of one compartment and as the waste water must reach a level on line with the top of the partition before it can overflow into the other compartment, which is connected to the soil stack, a perfect water seal is created. Trap has a threaded brass cover which allows the trap to be easily cleaned.

Refrigerators connected in this manner have been found to be great ice savers. It prevents hot air from entering the boxes, as it does when a pan is placed under the waste pipe of the refrigerator, as the waste pipe does not come within several inches of the top of the pan. Soil stack is usually of two or three-inch galvanized pipe with galvanized fittings. Stack should vent to the atmosphere and before it is connected to the soil pipe, a trap should be inserted.



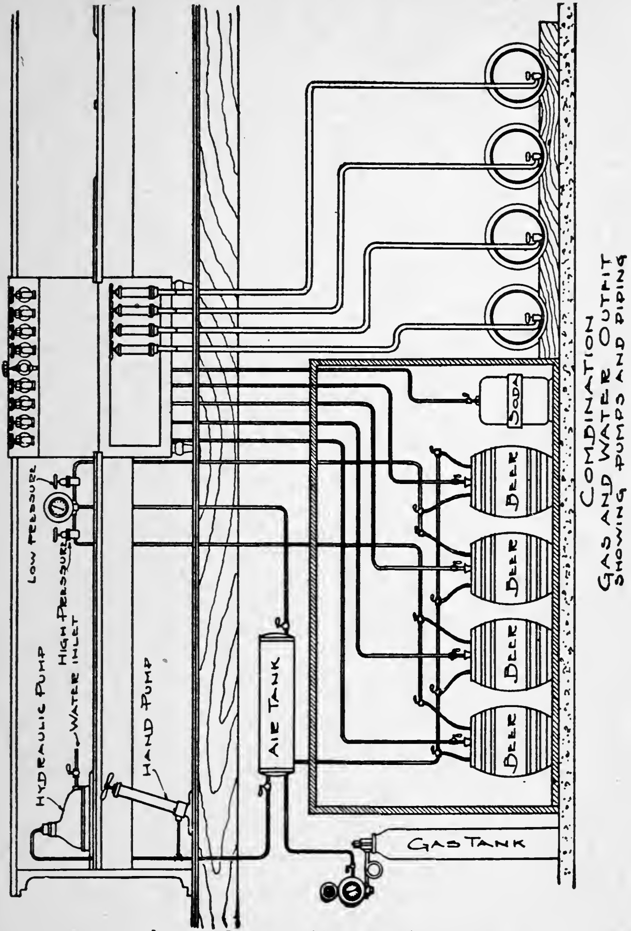
SANITARY CONNECTION OF REFRIGERATORS TO SOIL STACK.



Beer Pump and Piping

Illustration shown here is beer pumps and piping connection. Different makes of beer pumps; this will give a plumber a good knowledge of this kind of work. These cuts show hydraulic beer pump and carbon gas pump outfits.

Janette Automatic Electric Beer Pump. The principal feature of this pump is, that it is automatic in its



operating and can be set to operate at any pressure from 10 to 50 pounds, and when connected to a storage tank the air can be regulated.

The automatic cut-off is very simple, with the positive knock out never failing to start or stop the pump at the pressure desired. The connections as shown here are very simple to make if the sketch is followed outright. There is nothing to get out of order in the Janette Beer Pump.

A Plea for Correct Sewerage.

The close of the century witnessed a most remarkable development in the construction of plumbing and house drainage. Heretofore many earnest, well-meaning individuals not appreciating the importance of correct drainage, were inclined to sacrifice this vital factor in their buildings, to the adornment of their reception, dining and other rooms, not realizing that the very decorative feature on which so much time and expense were spent, might conceal a lurking enemy in the disguise of DEADLY SEWER GAS.

The presence of drain diseases, such as typhoid and scarlet fevers, dysentery, etc., coming frequently from no apparent cause led inquiring minds to investigate and as a result of their investigation, we attribute much of the improvement now noted in modern edifices. The same art which was heretofore employed for the embellishment of the more favored portion of a dwelling is now applied to bath and toilet rooms and their accompanying accessories, and knowledge and refinement have superseded ignorance and neglect. While all of this is a laudable step in the right direction, still it must be borne in mind that attractive fixtures may be attached to defective drains and a state of corruption may exist amidst the daintiest surroundings.

House drains convey from the house the liquid and solid refuse which animal life rejects. Waste is a necessary accompaniment in all conditions of life. The accumulated waste from food, clothing, bathing and other simple acts of daily existence tends to decay, which naturally becomes offensive and must be removed, or disease will ensue.

The drain therefore which encircles the abode and conveys the matter from dwellings must be absolutely perfect, even the slightest imperfection creates a chronic state of ill health or puzzling anaemia and oftentimes death. Every builder should weigh these facts well, he should familiarize himself with the drainage system of his house and adopt only that which is convincingly trustworthy in every respect.

There is another danger which must not be overlooked. Many families having closed up their homes during a period of travel, perceive on their return an offensive odor permeating the different apartments.

The difficulty is simply this—The water which stands in the traps of house pipes and which shuts off gases from the sewer when wash basins, etc., are in use, not receiving its customary supply, evaporates during the absence of occupants, and gases from the main sewer are permitted to enter.

For weeks, perhaps, there has been no water seal in the traps, the ascent of sewer air has been continuous, so that not only the air is utterly unfit to live in but curtains, carpets and other absorbing furnishings have become saturated with the pollution thus acquired.

Let it be remembered, that when lavatories, sinks and other fixtures are not in use they are gradually losing by evaporation the trapped water seal, and authorities have declared that sewer gas or sulphurated hydrogen is the most poisonous of all the gases of known composition, that it is heavier than the ordinary atmospheric air, that experiments have been made with it by chemical authorities which show that one part of the gas and two of the air will kill animal life. This gas therefore must be removed so far away from us that it cannot return in the form of dangerous invisible gases of decomposition.

It must then be obvious to any person that a thorough system of house drainage and plumbing is necessary in order that the building may be kept free from the pollution in public sewer and its poisonous air.

The remedy for this evil is not so very far away but what it can be very easily reached.

At the proceedings of the International Congress of Hygiene and Demography held at Washington, D. C., by the most eminent architects and sanitary engineers in the world, the most important subject discussed was the sanitation of the interiors of houses connected with the public sewers, and it was unanimously adopted that the end and object of the systematic drainage of a house is to endow it with a good system of water supply and discharge for waste water and to regularly flush the interior of the drains by clean pressure water, it being

Resolved, that the object will be the most certainly attained where the following essential rules are strictly observed: To exclude from the interior of our houses all sewer gas, to avoid pollution of the soil by fecal matter or waste water, to prevent the generation of deleterious gases in the soil and in the air below and around our houses, to discharge as rapidly as possible into the public sewer all fecal matter and waste matter produced.

The application of these essential rules necessitates an intercepting flushing, FRESH AIR INLET TRAP IN THE HOUSE DRAIN, inside main wall of cellar for THE EXCLUSION FROM THE HOUSE OF POLLUTIONS, AND SEWER GAS IN THE PUBLIC SEWERS, a proper system of ventilation, pipes that are air tight and water tight, the employment of proper materials for the pipes, proper dimensions and thicknesses for all pipes, FLUSHING AND CLEANSING JUNCTIONS WITH VERY OBTUSE ANGLES, proper construction of water closets, baths and other sanitary appliances, FACILITY OF ACCESS TO ALL HOUSE DRAIN PIPES FOR FLUSHING, INSPECTION AND TESTING THEM, sufficient CLEAN-OUT CONNECTIONS, periodical visitation and cleansing when necessary.

Every city, town or village in the United States has a plumbing ordinance of their own, and each thinks they have the best.

The plumbing that is shown in this book is the latest and best that can be done, and the illustrations can be followed **successfully.**

We show crown venting, also continual venting.

Ventilation of Sewer.

Sewers and drains, together with plumbing systems, are ventilated in order to carry off the gases mentioned and to protect the inhabitants of buildings from gas poison and infection.

Sewers are ventilated by manholes in the street, having perforated iron covers.

Drains are ventilated in the same manner and by the vent pipes in a plumbing system.

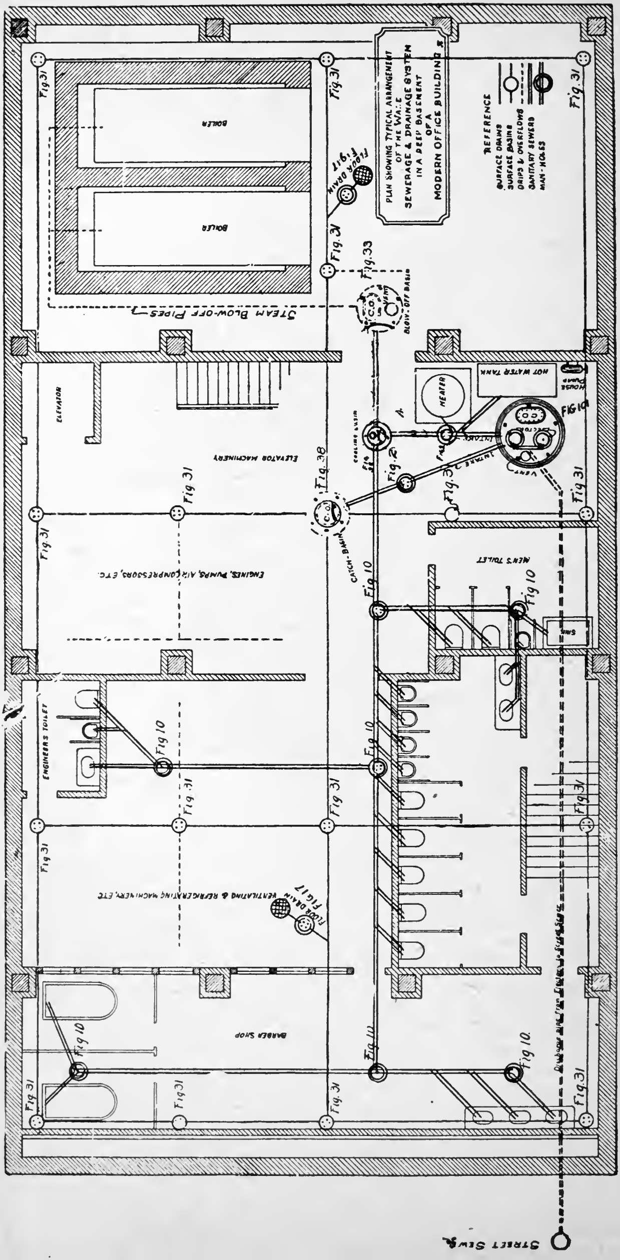
Plumbing systems are ventilated by the extension of soil and waste pipes through the roof of a building. Vent pipes are connected into these soil and waste pipes above the highest waste connection, or extended separately through the roof.

Vent pipes are designed to safeguard trap seals and provide for a circulation of air in the plumbing system.

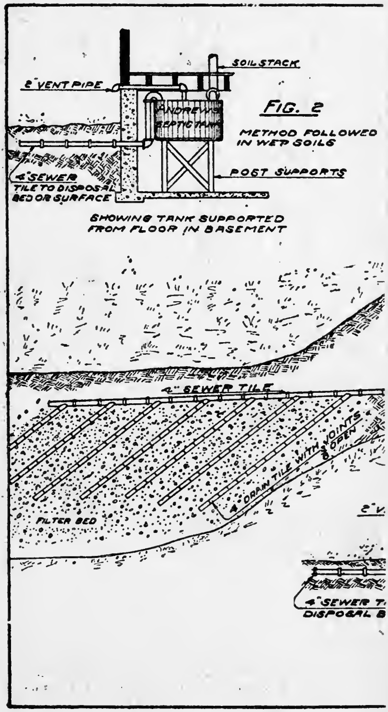
Trap seals are necessary to prevent the entrance of sewer gas to the living rooms.

If there were no vent pipes the accumulated gases would eventually pass through the water seal, or the latter would be lost by reason of air compression or vacuum.

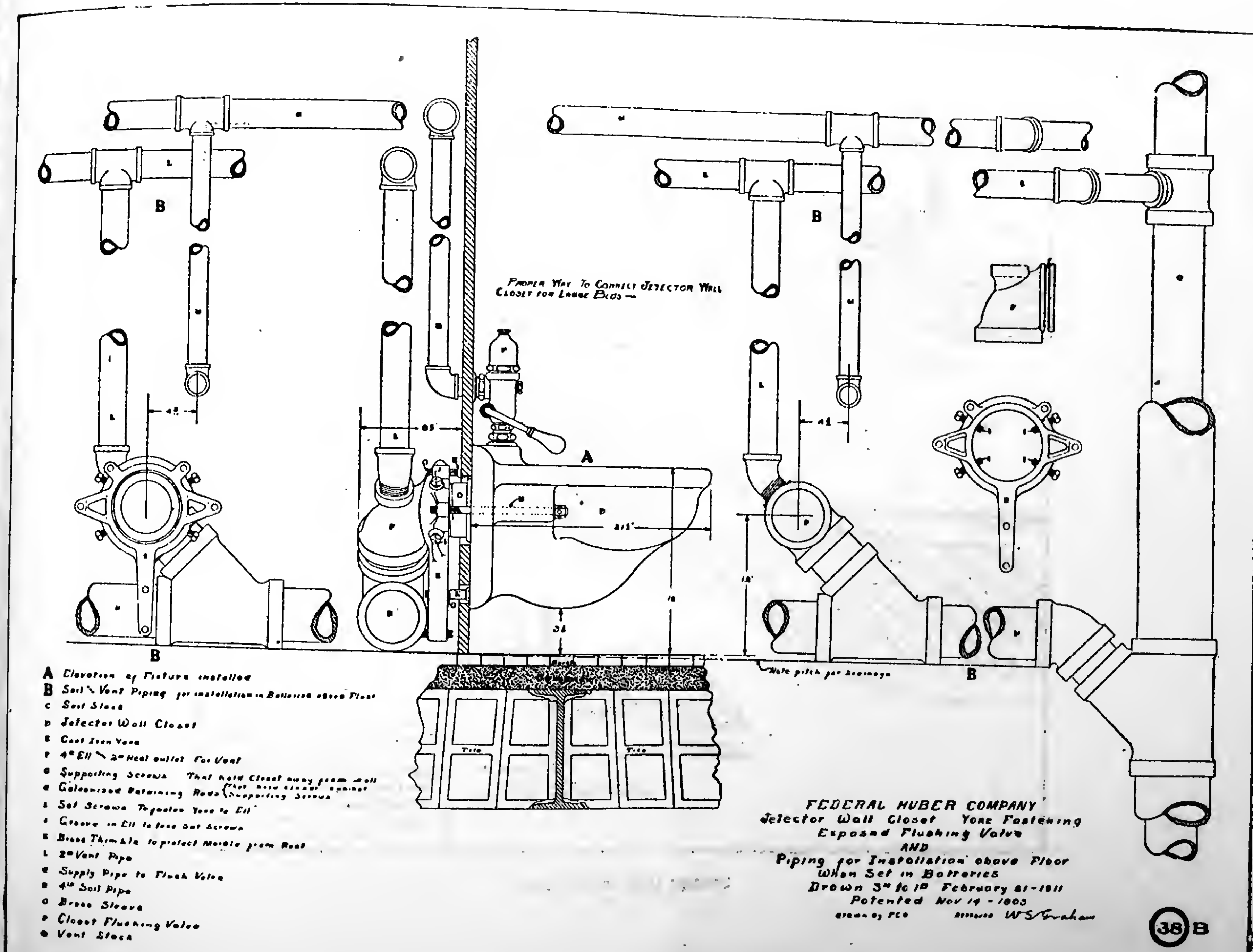
The installation of plumbing appears to be very simple. There is a reason for simple things. Ignorance of that reason may produce very serious consequences.



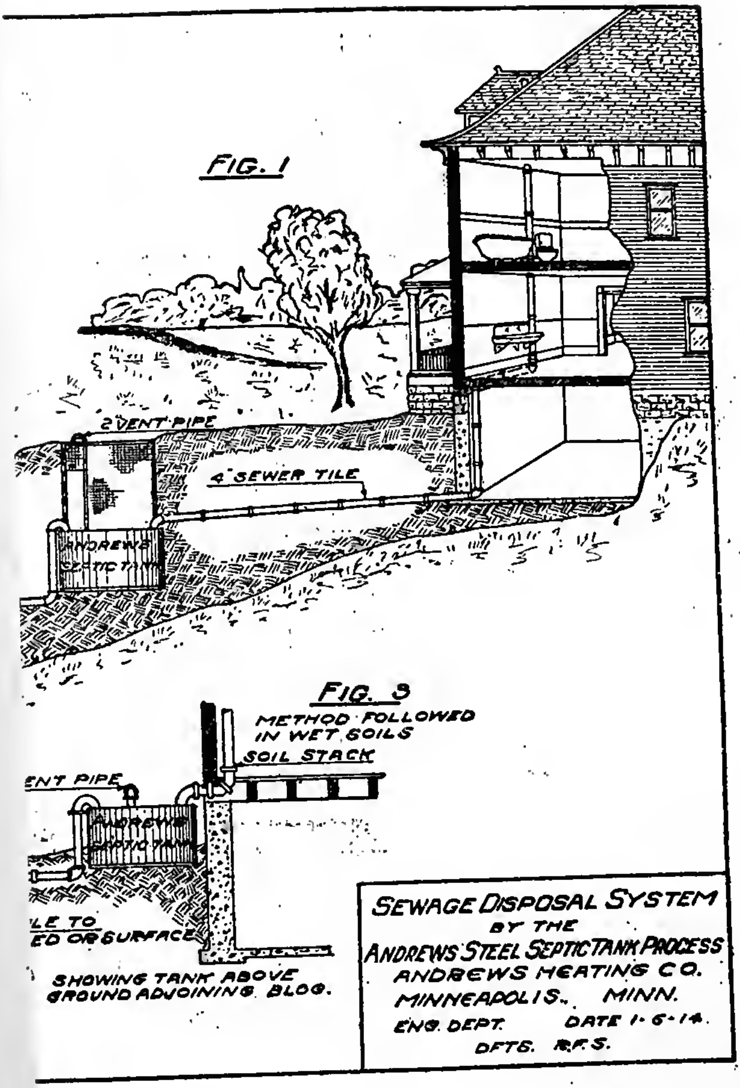
Drainage System—No. 102


SOIL STACK
2" VENT PIPE
FIG. 2
METHOD FOLLOWED IN WET SOILS
POST SUPPORTS
4" SEWER TILE TO DISPOSAL BED OR SURFACE
SHOWING TANK SUPPORTED FROM FLOOR IN BASEMENT
4" SEWER TILE
4" DRAIN TILE WITH JOINTS OPEN
FILTER BED
4" SEWER T
DISPOSAL B

Sewage



Proper Way To Connect Jetector Wall Closet for Large Bldg —
A
B
B
B
B
Note pitch for drainage
A Elevation of Fixture installed
B Soil & Vent Piping for installation in Batteries above Floor
C Soil Stack
D Jetector Wall Closet
E Cast Iron Yoke
F 4" Ell & 2" Heel outlet For Vent
G Supporting Screws That hold Closet away from wall
H Galvanized Retaining Rods (That hold closet against Supporting Screws
I Set Screws To fasten Yoke to Ell
J Groove in Ell to take Set Screws
K Brass Thimble to protect Marble from Rod
L 2" Vent Pipe
M Supply Pipe to Flush Valve
N 4" Soil Pipe
O Brass Sleeve
P Closet Flushing Valve
Q Vent Stack
FEDERAL HUBER COMPANY
Jetector Wall Closet Yoke Fastening
Exposed Flushing Valve
AND
Piping for Installation above Floor
When Set in Batteries
Drawn 3" to 1' February 21-1911
Patented Nov 14 - 1905
Drawn by FCO Approved W S Graham
38 B



Disposal System.

Wall Closets

This installation shows one of the latest sanitary installations, as used in one of the large public buildings.

We start from the main stack 5″ and then branch both ways to 4″ with 45° Ys, and nipple into a 45° ell and then raise with the nipple to 90° closet ell, which is grooved and has a 2″ top vent opening. The closet cast iron yoke is then attached to this grooved ell by chilled steel bolts which rest into the groove.

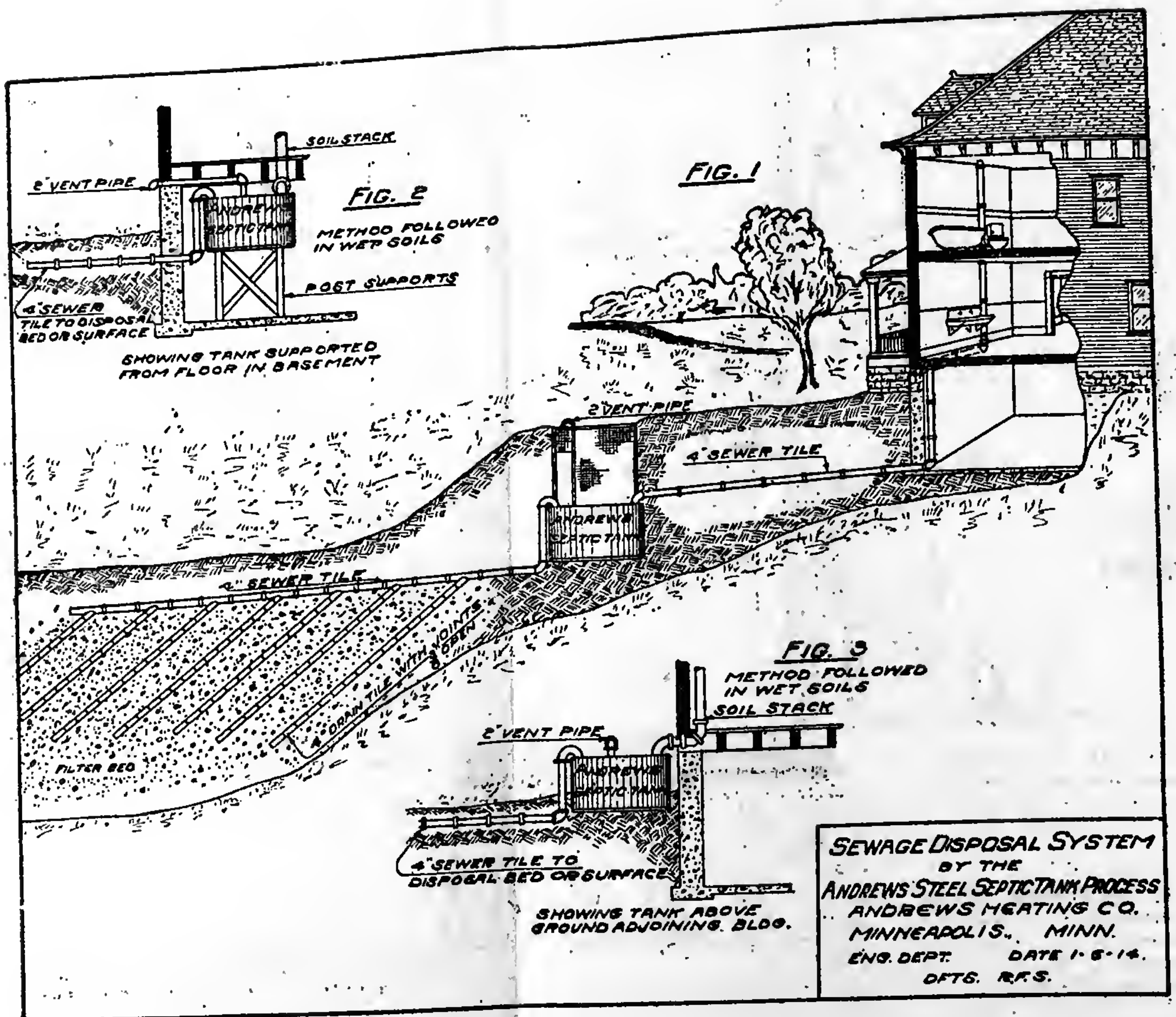
Into this grooved ell is then screwed a brass iron pipe threaded wall flange with a bell recess for gasket. The closet is then fastened to the yoke by two long holding bolts. The recessed horn of the closet slips into the gasket and brass wall flange. The closet does not receive any support from the wall at all. The three stud bolts, two on the top and one on the bottom, having hole cut out through wall and being screwed from the yoke and rest against the back of the wall, making it thereby, absolutely impossible to break the marble or wall at any time.

The vent is taken from the stack of 4″ and branches both ways as a tee and with 2″ drops into the top of the 4x2x4 grooved closet ell. The supplies are taken from the main riser of a three-inch into heads of 2½″, where they drop down to 1¼″ into an elbow into the stop of the closet valve.

This is based on a battery of twenty closets, as the size of batteries increase or diminish, the supply is reduced in proportion. On the soil waste this size is reduced according to the size of the number of closets in the battery.

This is one of the new installations for wall closets and also is adapted to wall urinals. The construction being so that the closet can be removed by just unfastening of the two holding bolts. On account of its construction of the two studs on the top and the one on the bottom, the breaking strength has never been fully determined, although tests have been made up to 1700 lbs. actual weight.

Another test being made, which is more severe on closets of this description, is not to see how much dead weight the closet will stand, but to see what conditions the joints are in, after subjecting the closet to a test of jumping on same.



Sewage Disposal System.

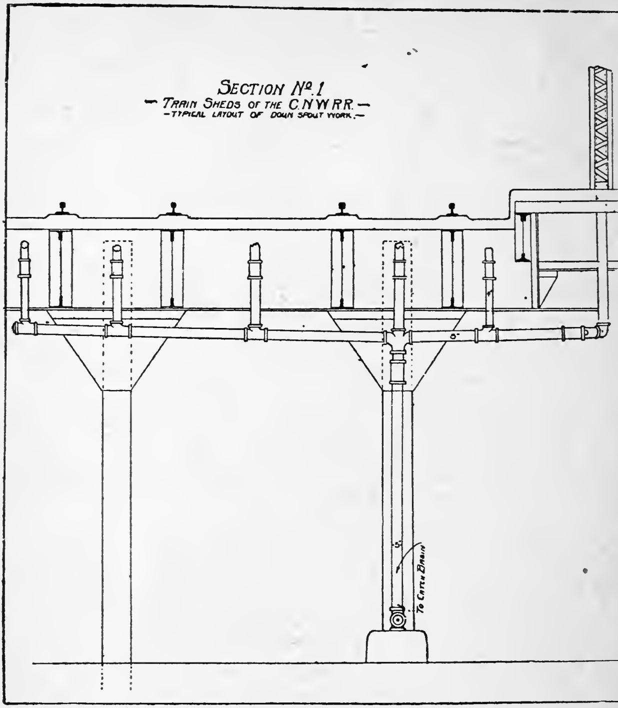
Sewage Disposal System

Among the various methods of disposing of sewage wastes in a sanitary manner, the septic tank system operated in conjunction with a sub-surface system of irrigation is the most easily adapted for a wide range of conditions. There are many modified forms of septic tank systems, which operate more or less satisfactorily in proportion to how closely the designer has followed the principles involved in the reduction of sewage wastes by this process. Present day practice and experience show that a septic tank sewage disposal system should possess the following features. There must be a reservoir or tank of suitable proportion to the number of persons to be served for retaining the sewage for a definite period, an automatic discharging device which empties the tank at definite intervals of time, a filter bed or irrigation field of suitable proportions and materials for final treatment of the liquids.

The accompanying illustration shows such a sewage disposal system with an Andrews steel septic tank designed for use in dwelling houses, school and public buildings. The tank is divided into two compartments called the intake and dosing chambers and is constructed of boiler plate ¼ inch thick, has riveted heads, hand-holes, automatic siphon, intake fitting and is made absolutely air tight. The location of the tank is shown for three different conditions, the one most frequently used being shown in Figure 1. Where the ground is level and there is no basement to drain, the locations shown in Figures 2 and 3 are desirable. As shown in Figure 1 ordinary 4-inch glazed sewer tile is laid with cemented joints, having a pitch of 1 inch in 20 feet between the house and the tank and from the tank to the disposal or filter bed. At the disposal bed ordinary Y branches are used with 4-inch porous drain tile laid with ⅜ inch open joints for branches. Pieces of tile should be laid above and underneath the joints so as to prevent dirt from getting into the branch pipes. These drain tiles are laid with a pitch of 1 inch in 25 feet.

Converting sewage into harmless liquids is a biological process and operates in the system as follows: All domestic sewage contains a certain percentage of bacteria, which under suitable conditions, which are present in the septic tank with the exclusion of air and light, will start up an active fermentation process which results in a decomposition of organic matters contained in the sewage. Organic solid matters are thereby reduced to liquids, gases and humus materials. A period of twelve to twenty-four hours is about as long as is required for this action to take place, after which the contents of the dosing chamber should be discharged to the filter or disposal bed. Here further bacterial action takes place due to organisms present at the surface of the soil, completing the reduction process. These organisms depend upon oxygen, consequently it is important to have the filter or disposal bed well aerated.

For the ordinary suburban or country home it is usual to allow about 20 gallons of water per occupant to get the capacity of the tank; 1 foot of drain tile per gallon of liquid discharged per twenty-four hours and 3 sq. ft. of area for the filter bed. Where the soil is of an open, porous condition, a special prepared filter bed is not necessary. It is customary to dig furrows and embed the tile below the surface about 12 inches. Where the ground is of an impervious nature, it is necessary to dig trenches 4 feet or 5 feet deep and 24 inches wide and fill in with gravel, sand or cinders to within 1 foot of the surface and embed the tile.



Drainage of New Depot

Drinking fountains are supplied with filtered water and cooled by an ice machine and pumped through a circulating system.

The fountains are distributed through the station, beneath the train shed and to the power house, covering a distance of four city blocks.

It requires 63 9-inch drain pipe connections to city mains to drain the entire plant. Four 4-inch water mains are provided.

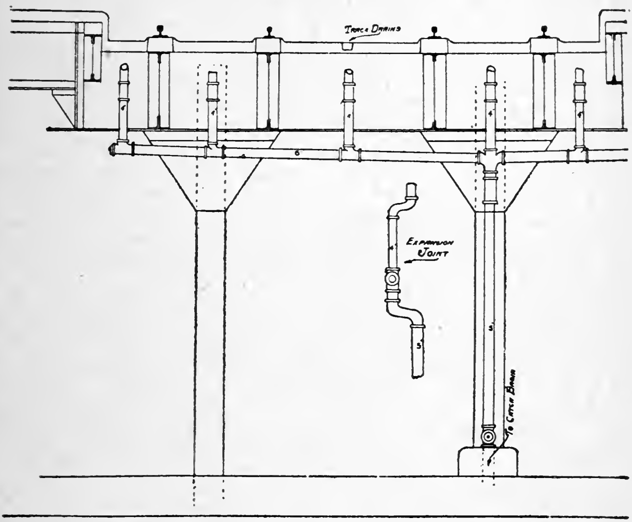
A series of cast iron settling basins are placed in the underground sewers which serves the down spouts and track drains. They are placed about 75 feet apart, one emptying into another. In this manner all the cinders and track rubbish is collected.

Women emigrants have a special arrangement providing a laundry equipped with 12 porcelain wash trays and a steam dryer, so that while waiting for trains, laundry work can be done.

There are also porcelain bath tubs for the use of the patrons of the C. & N. W. R. R. Co.

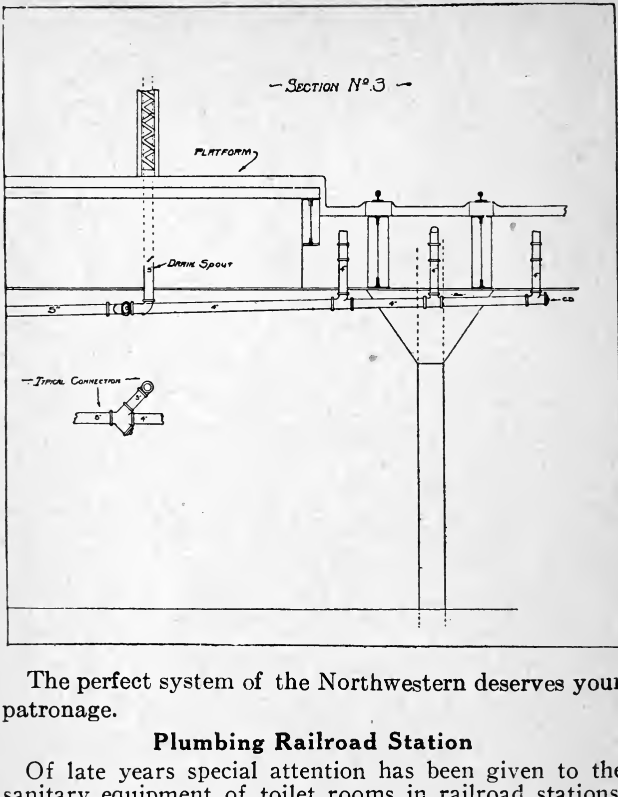
The women's toilet room of this station has accommodations for 3500 persons per day.

— SECTION Nº 2 —



Sections 1, 2 and 3 that are shown in this book are something out of the ordinary. Typical layout shows down spouts and its workings of the Chicago & North-Western train sheds. These sheds are the largest in the **world,** being 1200 feet long. There are 304 trains every 24 hours, in and out. Every one of these locomotives has to blow off steam, more or less. You will notice here in Section 2 that there is used in this work expansion joints made out of pipe. These expansion joints take care of expansion and contraction in case the down spouts get hot, as they naturally will, from high pressure steam from the locomotives.

This plumbing work was done by Hulbert & Dearsey, Chicago, Ill.

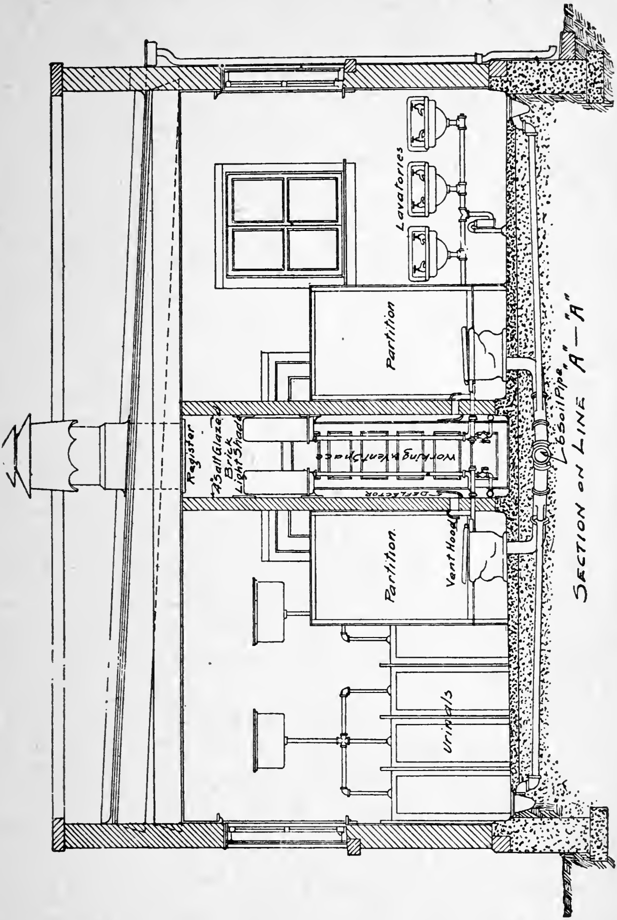


The perfect system of the Northwestern deserves your patronage.

Plumbing Railroad Station

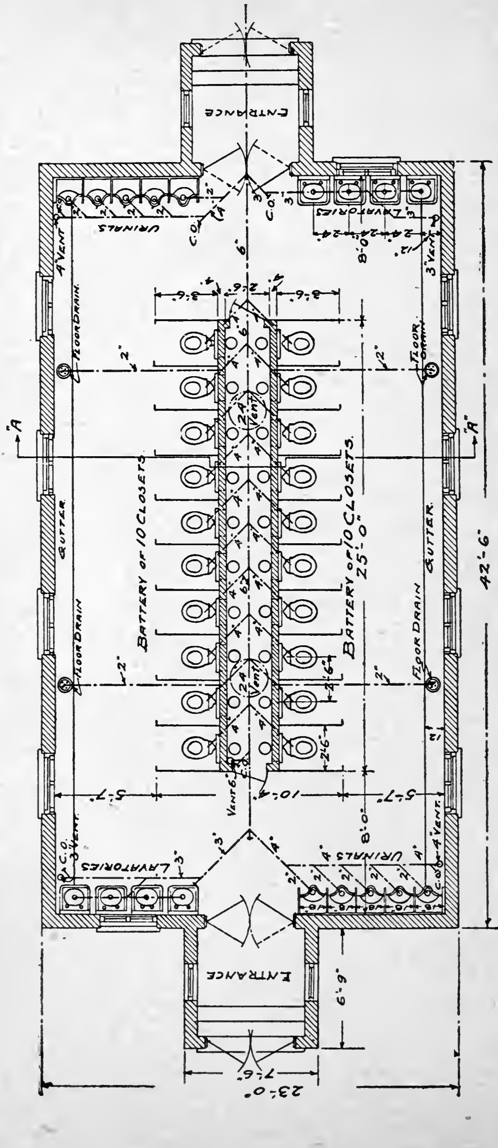
Of late years special attention has been given to the sanitary equipment of toilet rooms in railroad stations, public buildings and factories of all kinds, and public comfort stations are established at different parts of all our large cities.

All fixtures in these places are of the latest and most sanitary kind. Soil pipes, inside of buildings, are all extra strong C. I. soil pipe. Figures 1 and 2 show a plan view and cross section, respectively, of an up-to-date arrangement of the different fixtures in toilet rooms of this kind. Here a 2′ 6″ wide working and vent space is arranged. Walls for this working space are 4 inches thick of a light colored salt glazed brick. In the ceiling of this working space are located two 24-inch diameter ventilators. On either side of these walls are, in this case, a battery of

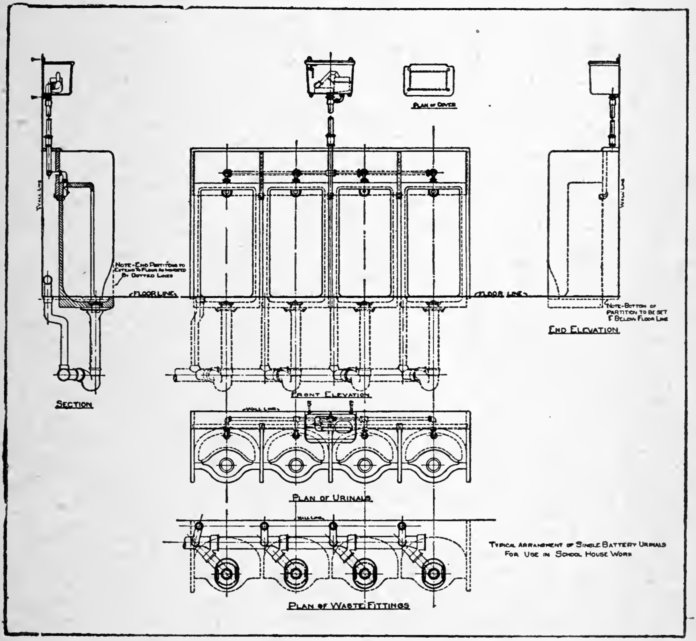


ten closets. In the walls, at the center of each closet, is located a 2¼-inch high by 16½-inch long opening with a vent hood in the rear of the closet and a deflector in the working space. Through the large ventilators in the ceiling of the work room a draught or circulation is created which draws the foul air out of the stalls. The deflectors force the foul air upwards along the walls.

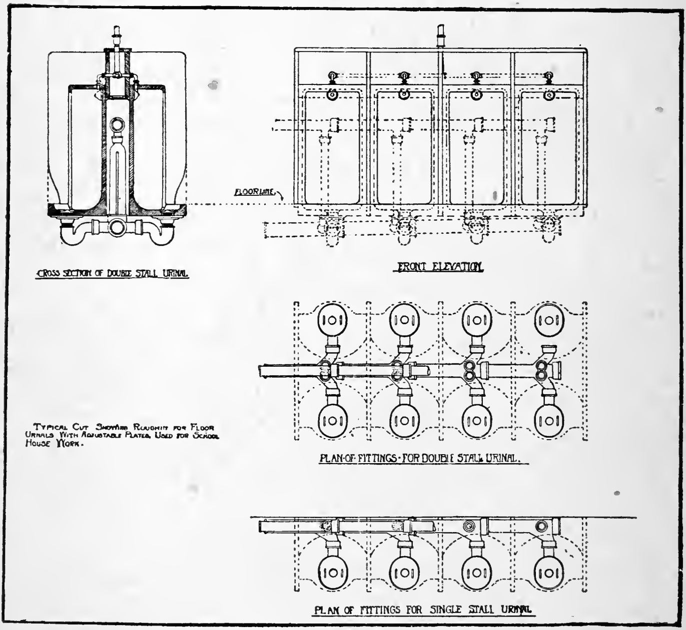
At each end wall of the room are located five urinals and four lavatories. Lavatories are supplied with hot and cold water. Automatic closets and urinals should always be used.


ENTRANCE
URINALS
LAVATORIES
4" VENT
3" VENT
FLOOR DRAIN
GUTTER
BATTERY OF 10 CLOSETS
BATTERY OF 10 CLOSETS 25'-0"
42'-6"
6'-9"
7'-6"
23'-0"
"A"

PLAN VIEW.



Arrangement of Single Battery Urinals



Urinal Fittings for Double and Single Stalls

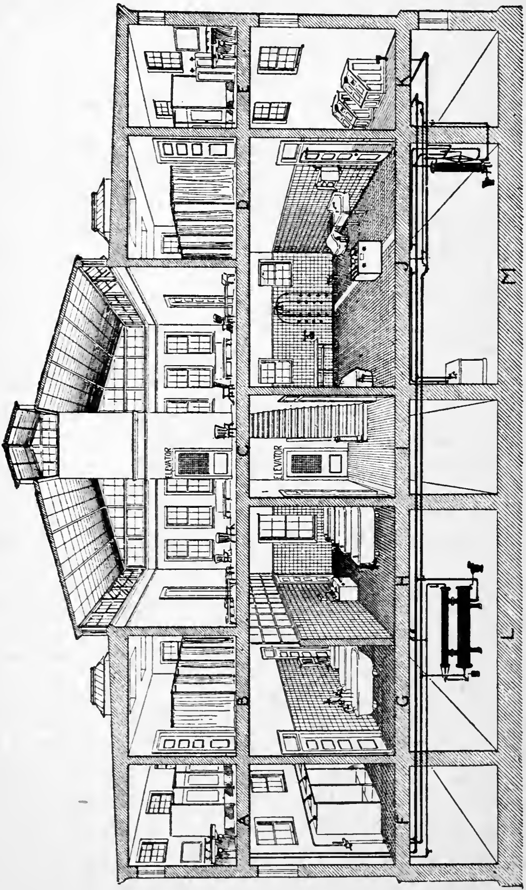
Installation of Control Apparatus for Administering Hydrotherapeutic Treatment

After the selection of apparatus and fixtures that are essential for complete Hydrotherapeutic Equipment is made, same should be located as indicated in room marked "J," sectional view showing interior medical bath establishment, on opposite page.

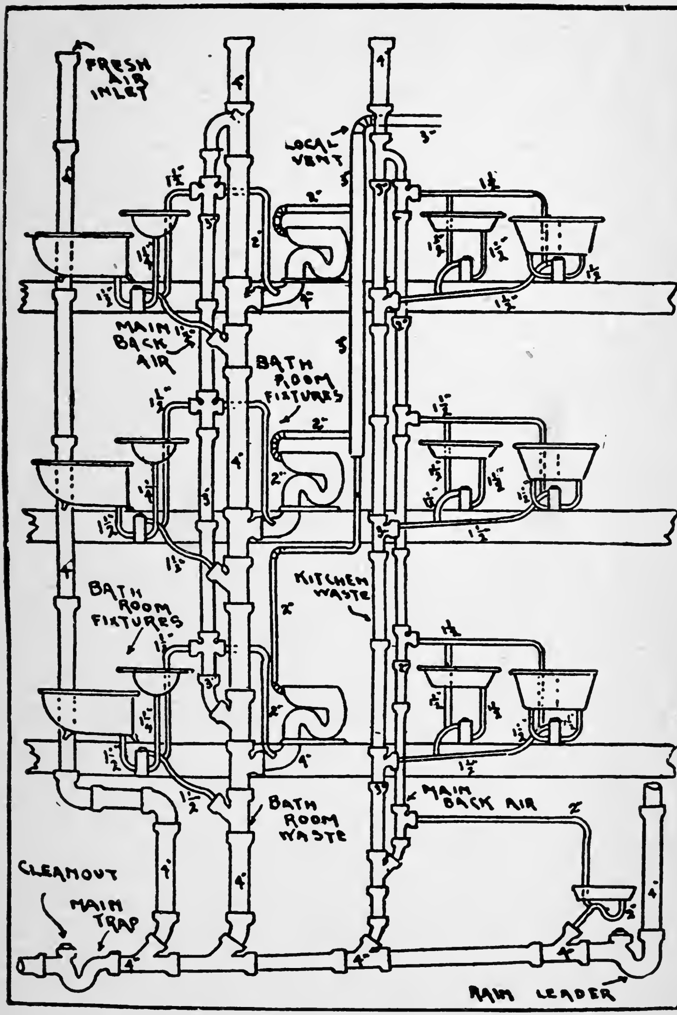
To insure absolute control of the temperatures in order that the treatment may be administered in a scientific manner, equal pressures or both hot and cold are essential, and an adequate supply of hot water furnished, delivered to this apparatus at a regulated temperature that may be maintained at 140 degrees Fahrenheit.

The most satisfactory method is to use a separate heater automatically controlled as shown in room marked "M." The addition of a storage tank to the heater indicated will add greatly to the accuracy; with this the control table will operate at times when a small particle is lodged temporarily under the seat of the valve which controls the steam leading to the heater. The maximum pressure used on both hot and cold is 40 pounds. Assuming that the pressure in the building indicated in the drawing would be greater than 40 pounds, the installation of a pressure reducing valve in the corridor, underneath room marked "K" with branch leading from same on the cold side to the apparatus, also through the heater and out again to furnish the hot water will give ideal conditions.

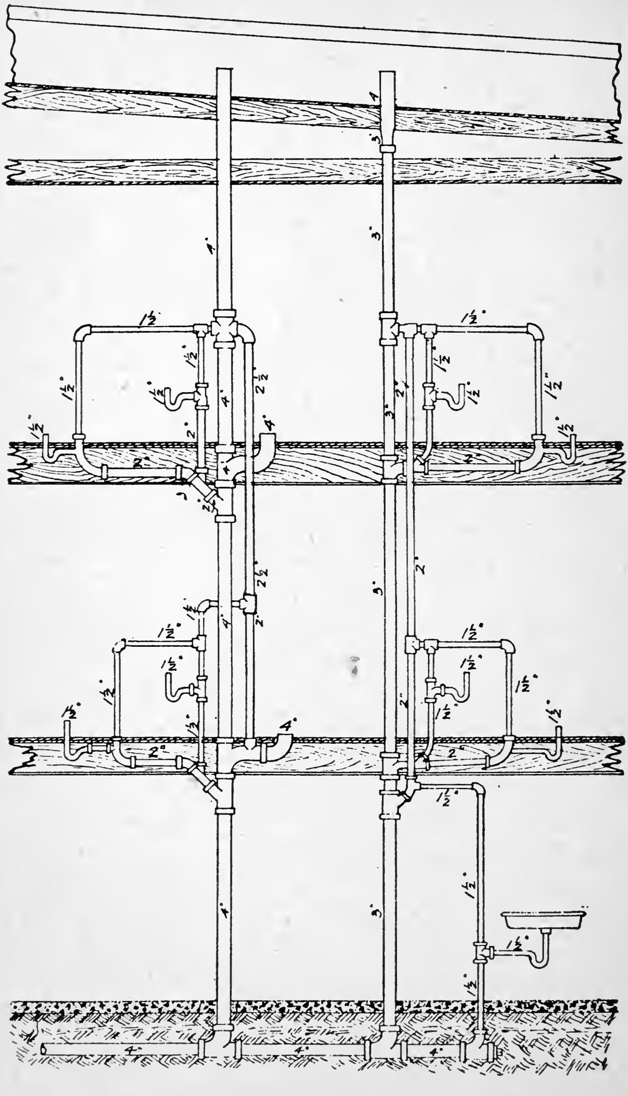
It is not intended that the patient should be submitted to direct application of ice water. The cooling chest shown in room marked "M" should be of ample size to furnish sufficient ice water to reduce the temperature of the cold for a few seconds in order that a cold dash at a temperature not lower than 54 degrees be given. The supply of hot and cold leading to the control apparatus should not be less than 1½ inches for hot, and 1½ inches for cold water.



Installation of Control of Apparatus for Administering Hydrotherapeutic Treatment.
By J. L. Mott Iron Works, New York

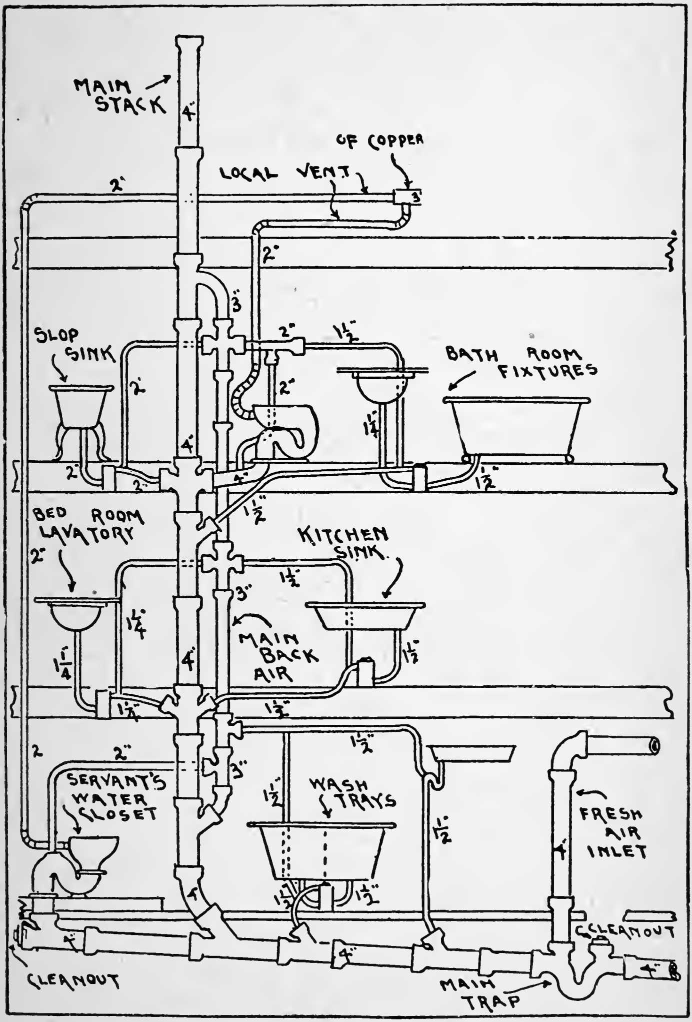


Plumbing for Flat Building

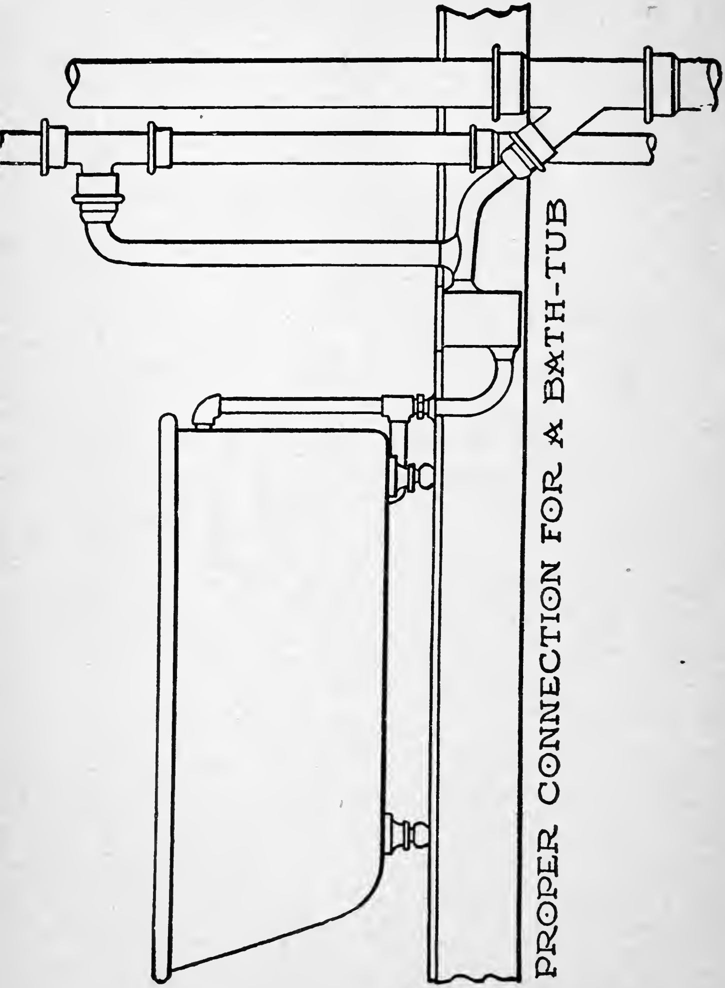


PLUMBING FOR FLAT BUILDINGS.

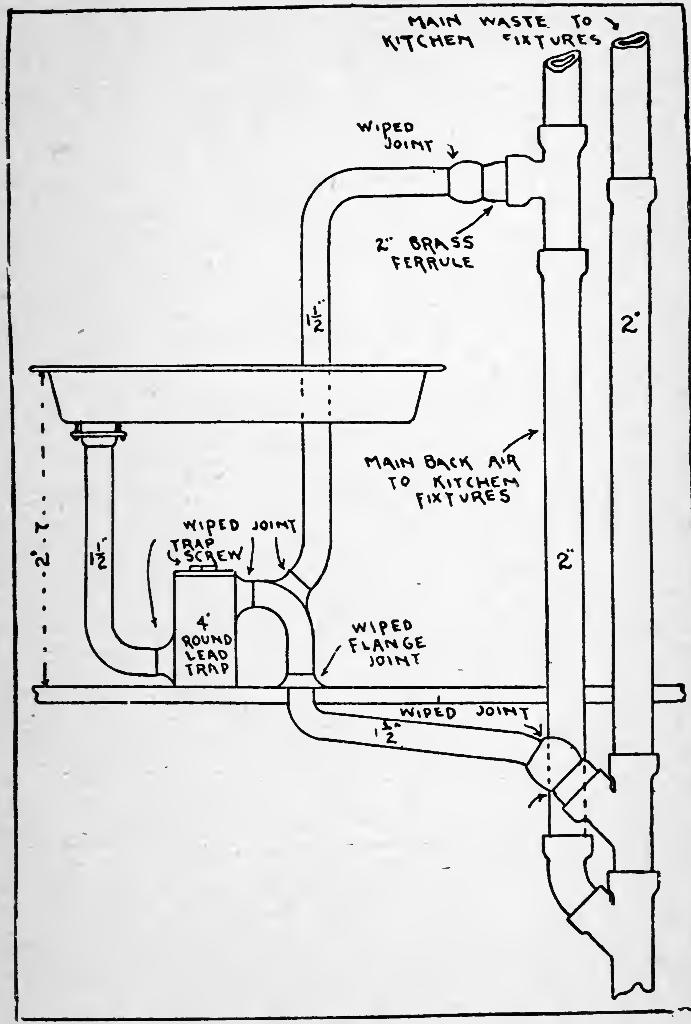
This is the system used for roughing-in in Pasadena, Calif.
Courtesy of the Chief Plumbing Inspector.



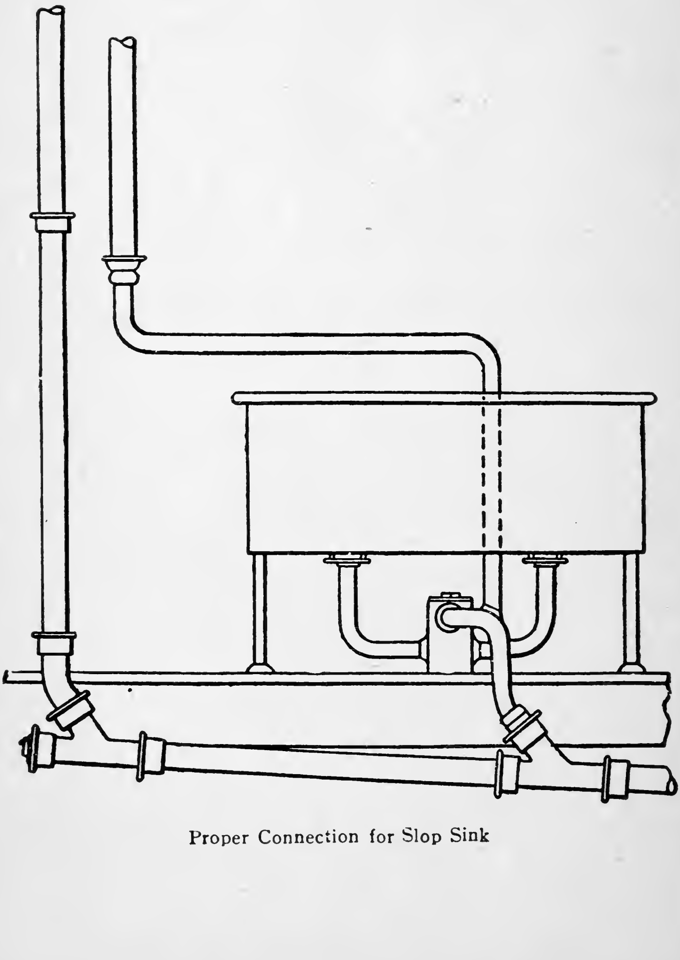
Plumbing for Residence



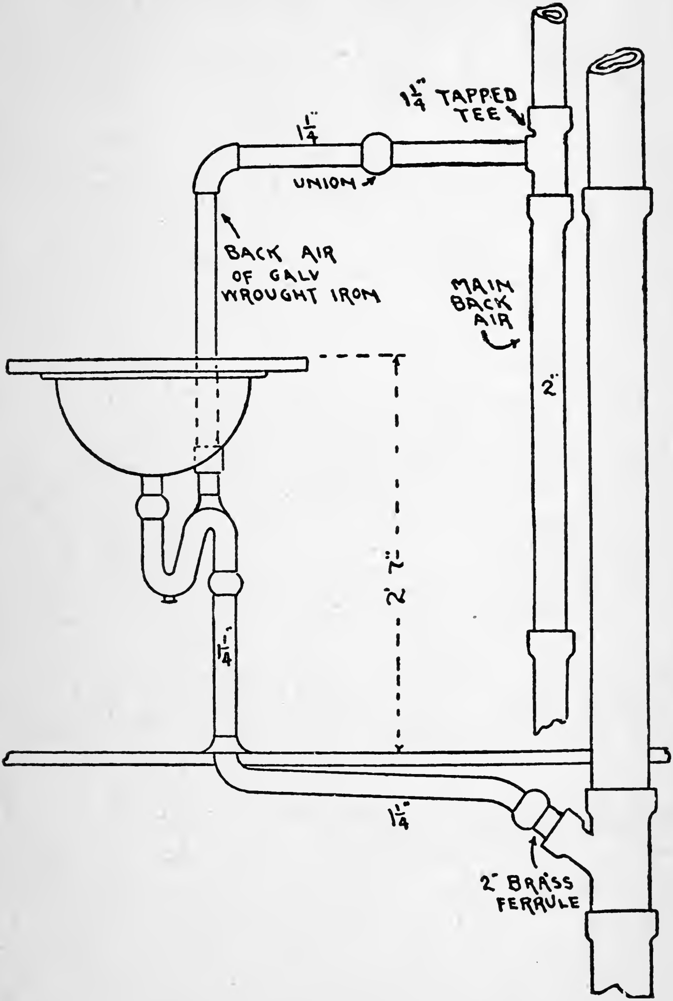
PROPER CONNECTION FOR A BATH-TUB



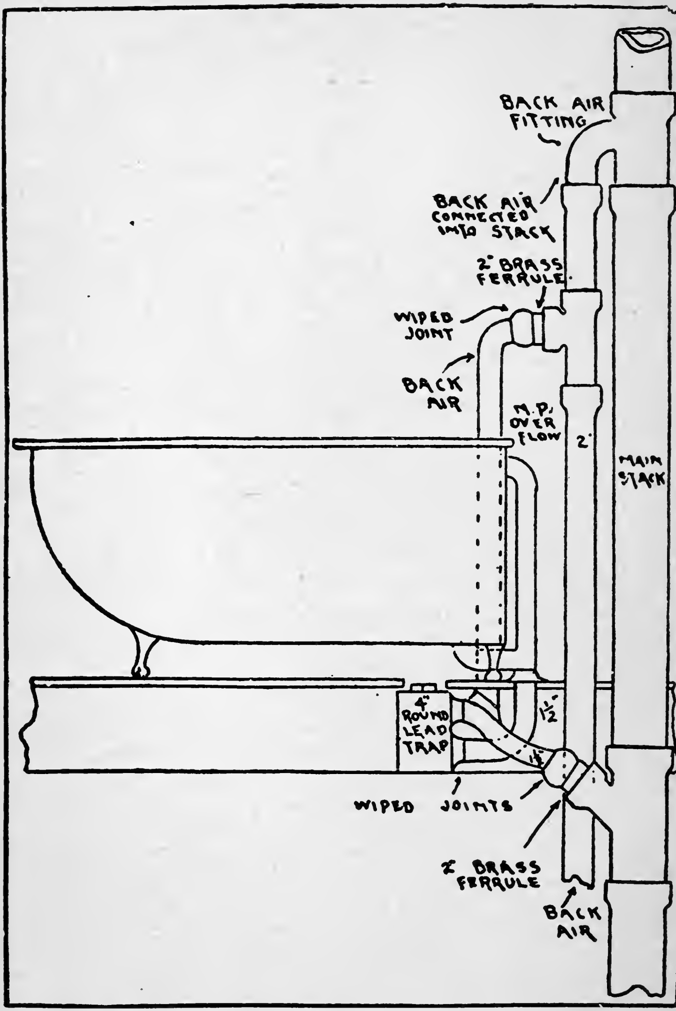
Proper Connection for Kitchen Sink



Proper Connection for Slop Sink



Lavatory Connection



Bath Tub Connection

Installation of Sanitary Plumbing

In the pages following is shown by simple sketches, the proper method of installing perfectly sanitary work in accordance with the ideas of the best sanitary experts in this country.

Each of our large cities has its own distinctive health ordinances, to govern the installation of plumbing and sewerage, but all these ordinances can be placed under two general heads: The first being; those that specify a house trap inside the foundation wall, and do not specify a catch basin. The second; those that specify that sinks must waste into a catch basin, and do not allow the use of house traps.

These sketches show proper installations for each of these general systems.

As it is impracticable to show sketches which will comply with every ordinance, sketches are given showing correct and sanitary installations in the two general classes.

In Fig. 43 is shown the waste and vent connections pertaining to the plumbing in an ordinary dwelling, in accordance with the general run of plumbing ordinances, which specify that the waste from sinks must be carried to a catch basin before entering sewer.

A. 2" extra heavy soil pipe from catch basin in yard to a point about 12" below roof.

B. 2" galv. iron, or extra heavy soil revent pipe from increaser F. near roof, to a point in soil pipe, C. below lowest fixture revented. The revent from each individual trap should be carried up to a point at least 3 feet above floor before making connection with vent line. This is to prevent the fixture from wasting through the vent pipe, in case of stoppage in waste or soil pipe. In some cities the ordinances

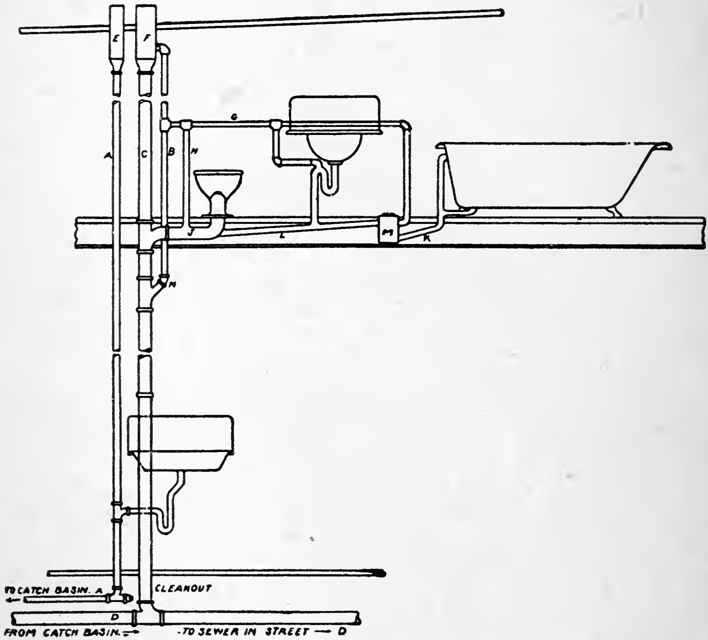

E
F
G
A
C
B
H
J
L
M
K
N
TO CATCH BASIN. A
CLEANOUT
D
FROM CATCH BASIN.
TO SEWER IN STREET — D

Fig. 43

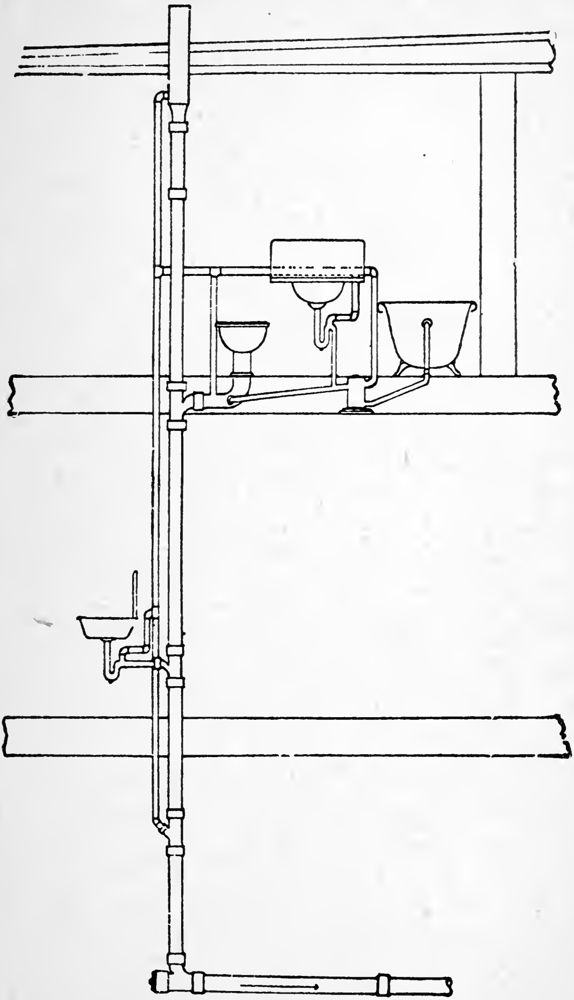


Fig. 44.

allow the connection of revent "B" to stack "C" at any point above the highest fixture wasting into stack.

C. 4" extra heavy soil pipe stack, from sewer in basement to a point about 12" below roof.

D. House sewer of 4" extra heavy soil pipe from catch basin to a point about 10 feet outside of foundation wall. From this point to sewer in street, the sewer may be 6" salt glazed sewer pipe.

E. 2x4 extra heavy increaser 30" long.

F. 4x5 extra heavy increaser 30" long with 2" side outlet for revent pipe.

G. 1½" galv. revent pipe to lavatory trap and bath trap.

H. 2" galv. revent pipe to 4" lead bend or to crown of closet trap. Some cities compel the use of extra heavy soil pipe for "G" and "H." In cases where but one fixture wastes into stack, the revent is unnecessary. For instance, note that sink trap in sketch is not revented as the sink is the only fixture wasting into stack "A." In cases of this kind, the fixture should not be more than 5 ft. from stack.

J. 4" lead bend for closet waste.

K. and L. 1½" lead pipe, 3 lbs. per ft from bath tub to drum trap, and from drum trap to lead bend.

M. 4" lead drum trap.

N. connection of revent to 4" main stack.

Fig. 44 is practically the same as Fig. 43, except that it shows the work done in accordance with ordinances which do not compel the use of the catch basin.

In Fig 45 is shown the correct method of installing the plumbing in a flat building in cases where catch basins are used. The descriptions are same as given for Fig. 43 and this sketch will apply equally well to flat buildings of three and four stories. For buildings of a greater height than four stories it is only necessary to increase the size of the sewer

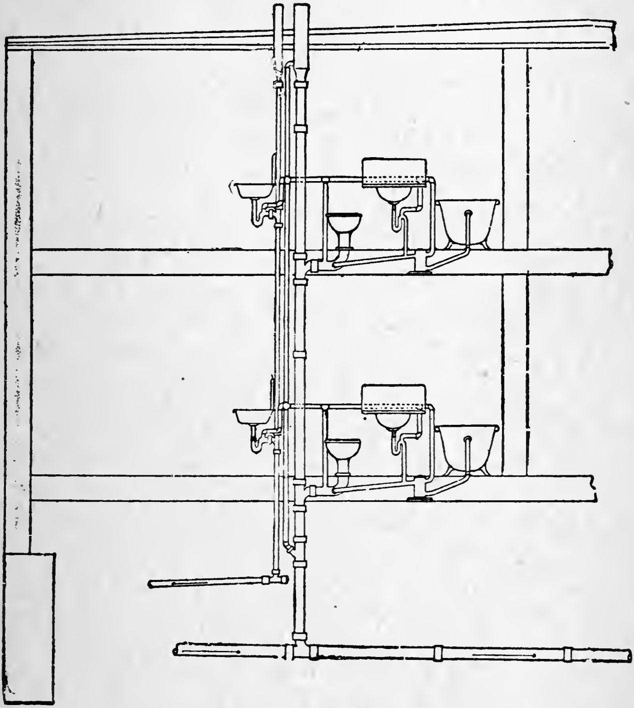


Fig. 45.

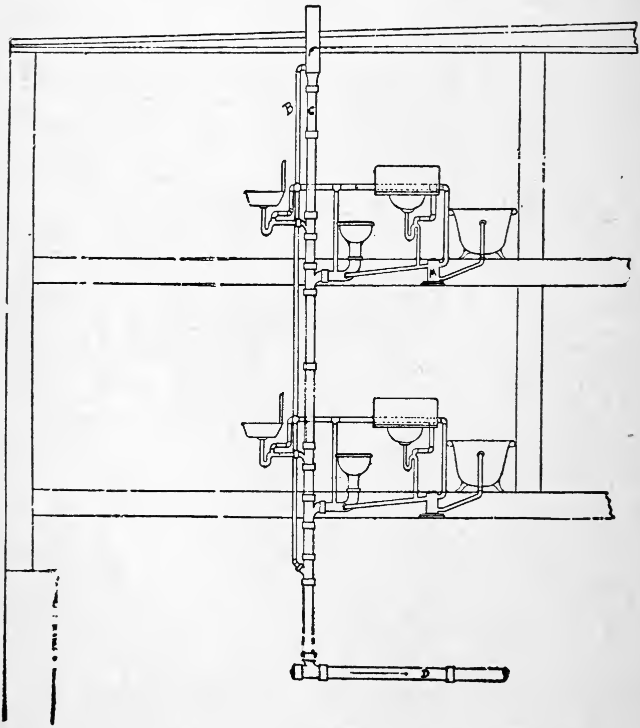


Fig 46.

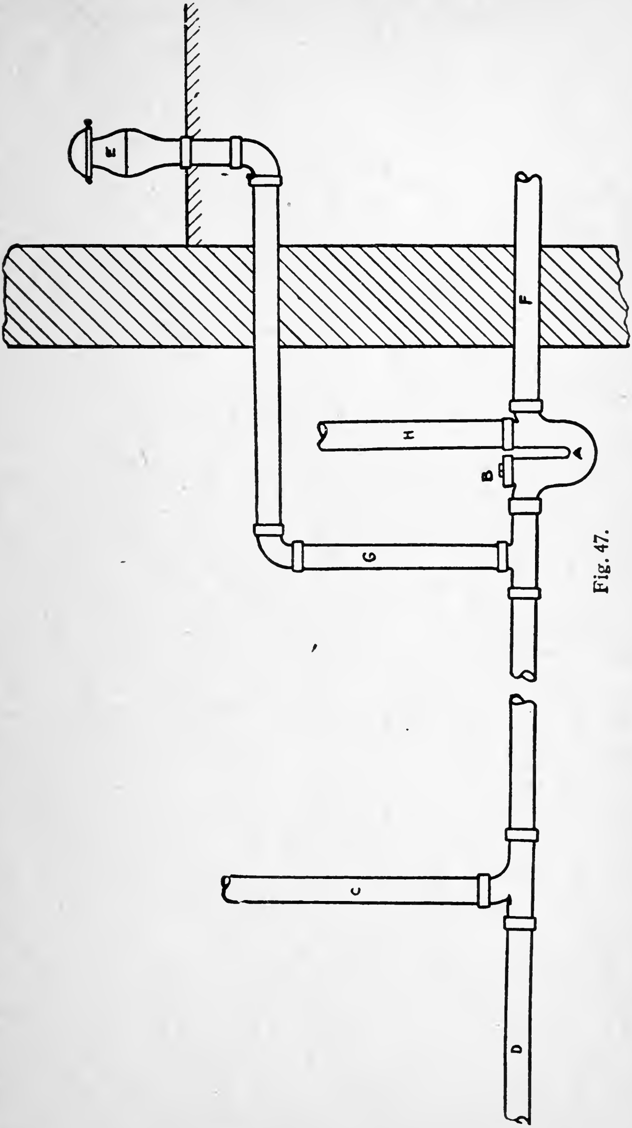


Fig. 47.

"D," the main stack, "C," the sink stack "A" and the revent stack "B."

Fig. 46 is practically the same as Fig. 45, except that it shows the work done in accordance with ordinances which do not compel the use of the catch basin.

Fig. 47. In this sketch is shown the proper method of placing a house trap with fresh air inlet. As fresh air inlets are frequently more of a menace than a benefit to health, it is advisable to use the Ayres inlet, as this fitting will prevent the escape of sewer gas from the fresh air inlet in case of a down draft in the soil pipe. As the house trap prevents the ventilation of the street sewer through the roofs of dwellings, the sewer gas naturally escapes at the street level. To obviate this, it is advisable to run a 4" extra heavy soil pipe stack from the street side of trap, directly through roof.

B. Cleanout.
C. 4" main stack.
D. 4" house sewer.
E. Ayres fresh air inlet.
F. 4" extra heavy soil pipe, connecting with salt glazed sewer, 10 ft. outside of foundation wall.
G. 4" extra heavy fresh air inlet pipe.
H. 4" extra heavy vent through roof.

Fig. 48. In this figure is shown the general construction of the catch basin. It should be made with hard burned brick laid in cement with a stone or cement cover, and a removable iron cover. It should be at least 3 ft. in diameter, have a depth of at least 3 ft. below the water line, and carried up to grade. The trap should be built of brick, or can be made by using a quart r bend turned down from the sewer pipe. The inlets from the sink and from the down spouts should be at least 6" above the water line. Catch basins should be placed not nearer than 10 ft. from the foundation wall, and the water level in the catch basin should be below the line of the

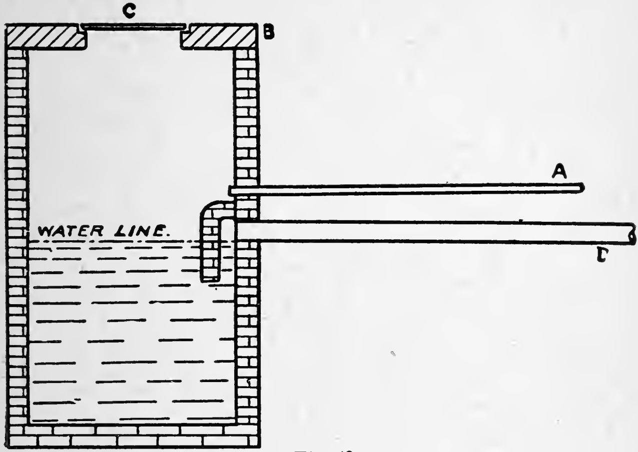


Fig. 48.

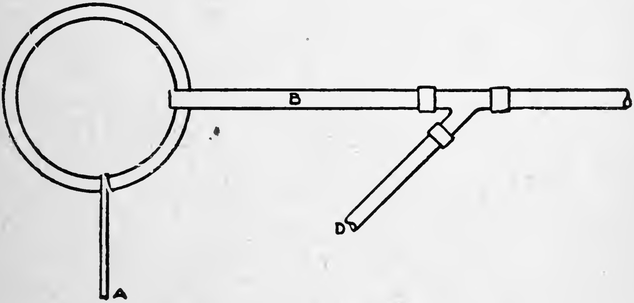


Fig. 49.

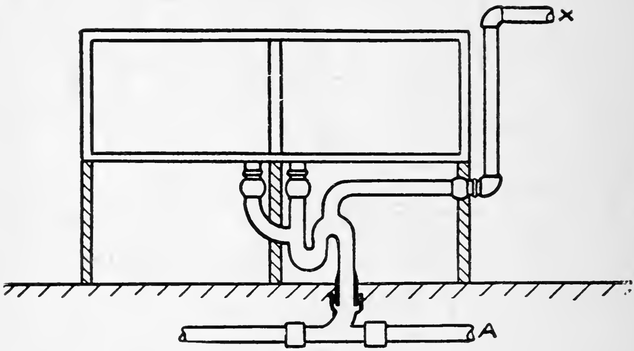


Fig. 50.

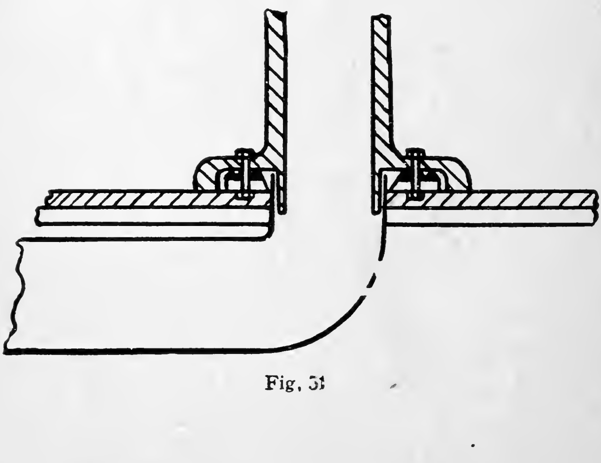


Fig. 51

basement floor. In the sketch, "A" represents the sink waste, "B" the stone cover, "C" the removable iron cover, and "D" the house sewer.

Fig. 49. In cases where the catch basin is placed at the side of the house the connection should be made as shown in Fig. 49.

Fig. 50. In this sketch is shown the proper method of connecting the waste and vent of a laundry tub. The pipes and trap should not be less than 1½". The trap is connected as shown to the house sewer or sink waste to catch basin, as the case mav be. The revent should be connected to the revent stack "B." In branching into the trap it is advisable to make connection below the water level of trap, to prevent circulation of air in the waste pipe between the tubs.

Fig. 51. In this sketch is shown a simple and sanitary method of setting a closet. The lead bend should be cut off on a level with the top of brass floor flange. Cut out the floor to allow for the square end of closet bolts. Place the closet flange with the bolts over the lead bend after tinning the concave surface of the flange, and shaving the outside of the bend. Now place your closet bowl on the flange to be sure you are right. Remove the closet bowl and screw the flange to the floor. Fill the space between the flange and lead bend with solder and make it perfectly tight. Then place litharge or red lead on the brass floor flange, set the closet, and screw heads on bolts. Putty should never be used, except to level up the closet, or to fill in the space between the base and the floor.

In Figs. 52, 53, 54, and 55 is shown the plan and piping for a factory, school or public toilet room. Fig. 52 shows the floor plan of the toilet room. Fig. 53 is a cross section showing the waste and vent piping for the closets and urinals. Fig. 54 shows the waste and vent piping for the wash and slop sinks.

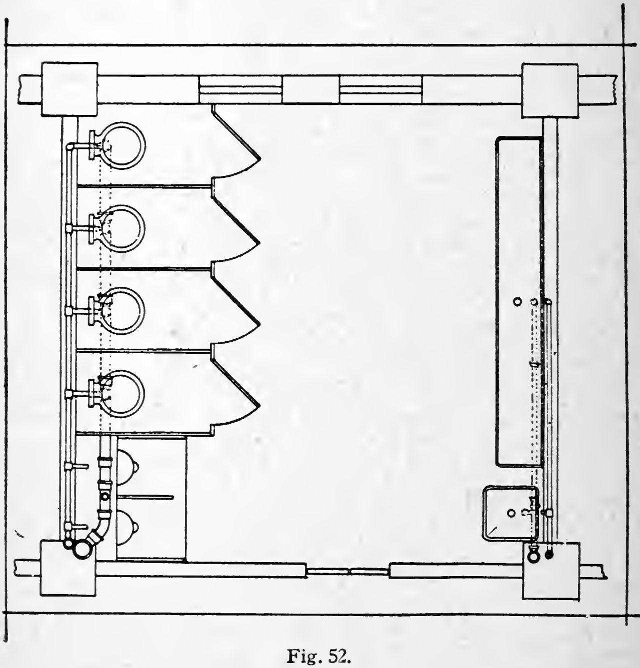


Fig. 52.

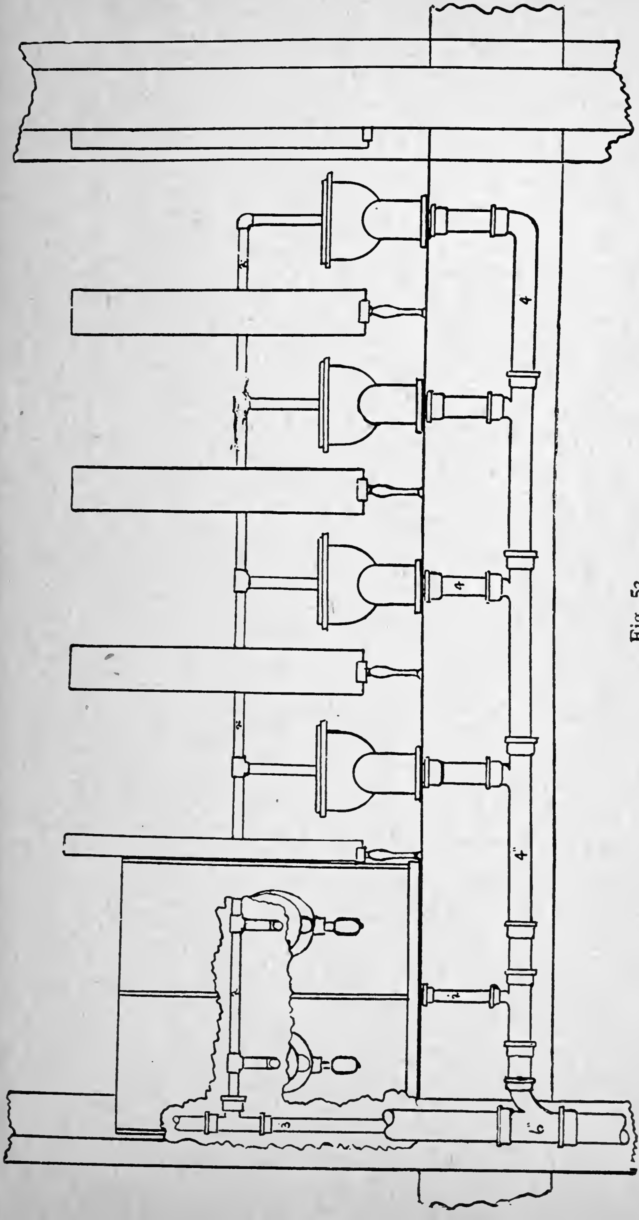


Fig. 53.

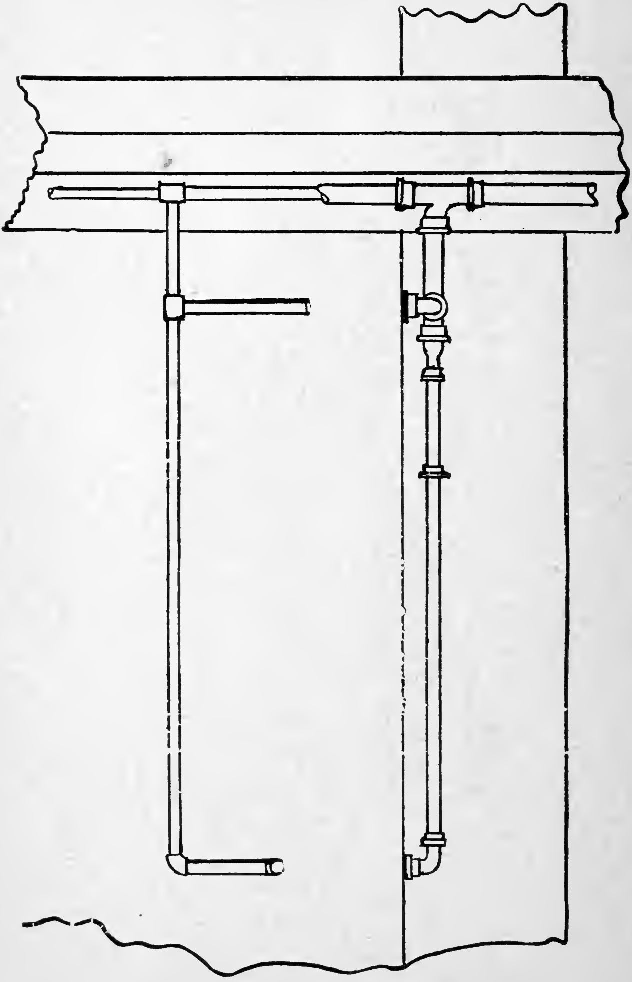


Fig. 55.

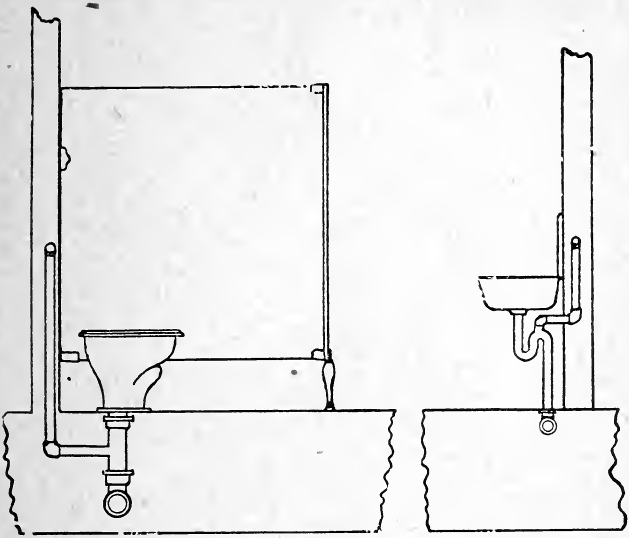
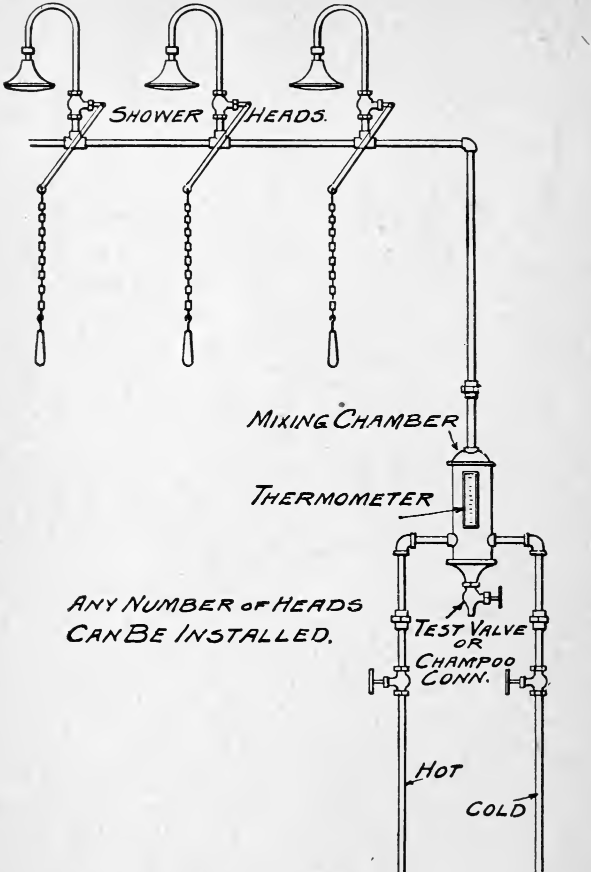


Fig. 55.

Fig. 55 shows method of connecting vent for closets and wash sink. For work of this kind it is always advisable and should be compulsory to use individual automatic closets and urinals. For schools, urinal stalls may be used, but they should be of the type known as ventilated urinals in which the water is continually running. The wash sink should be omitted in schools, but in place of this a long drinking fountain is installed in the basement, in some room other than the toilet room. Range closets are not sanitary fixtures, and should in no cases be used.



TYPICAL MODERN SHOWER BATH

The above cut shows complete installation.

A movement is now spreading over the whole country for the abolition of the bath tub because it is considered unsanitary.

The only satisfactory arrangement for the bath is the modern sanitary shower.

Swimming Pools.

Swimming pools are one of the most popular recreations in connection with clubs, hotels and even private homes. They have become so numerous in the past few years that a great deal of attention is being given to the method of heating and purifying the water.

Besides the material used in the construction of the tank itself, which is white porcelain tile, the equipment of some of the swimming pools is almost a gymnasium erected over the water; trapeze, swinging rings extending a good portion over the length of the pool, toboggan slides, etc., are only a few of the amusements which make the swimming pool popular and healthful as a recreation with exercise combined.

The standard size pool contains approximately 56,000 gallons of water; the bottom graduated from 2 feet to 8 feet in depth, which gives ample allowance for diving, plunging and swimming requirements. The width is approximately 24 feet, while the length is about 60 feet, this being the regulation size and which permits a large number of bathers to be accommodated at one time.

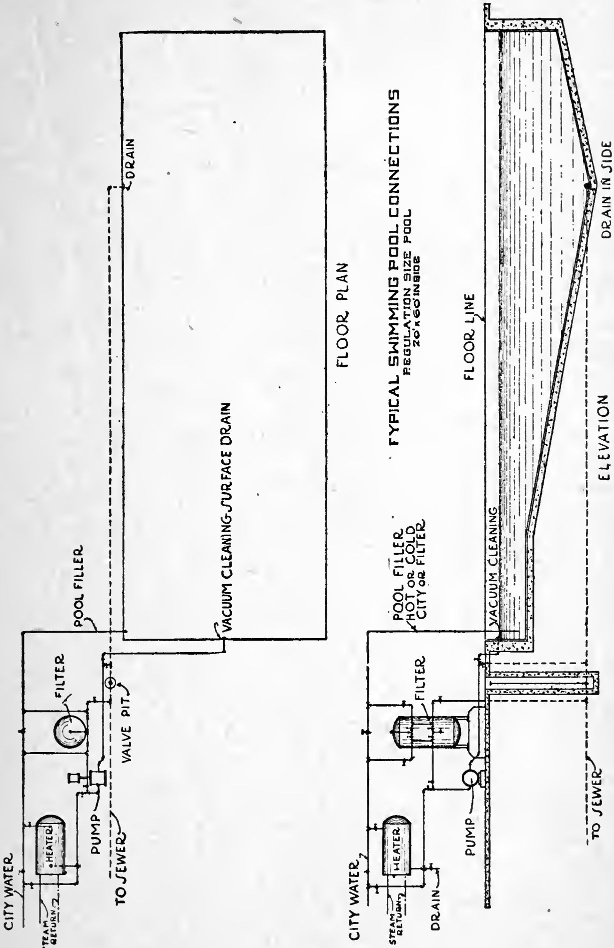
It is, nevertheless, a very important matter that the condition of the water should be given serious consideration—many bathers soon contaminate a water supply. Besides this fact, the water which is originally supplied to the pool (city water supply or river water supply as the case may be) should be filtered so that when the pool is filled to the brim you will be able to recognize a 10 cent piece lying flat on the bottom in the deepest place.

During the last few years, before cleaning the water in the pool was given much consideration, a person diving was not visible below the surface, which condition was responsible for a number of deaths either by accident or cramps, as the case might be, and when the body remained on the bottom of the pool it was not missed, in some instances from 12 to 18 hours. The possibility of this condition is entirely eliminated when a proper method of filtration is used. After the pool is first filled with clean, sparkling water, it should be circulated through the filter and back into the pool by using a pump and motor, which remain in constant duty when the pool is in service, thereby eliminating from the water in the pool all of the impurities accumulated, which will be caught in the filter and eventually washed to the sewer. The vacuum system used in con-

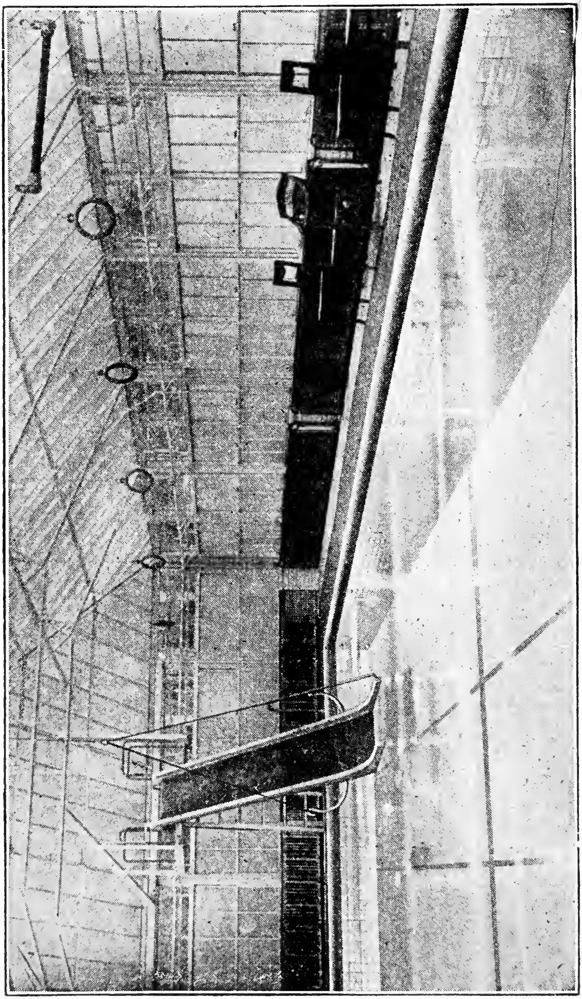
nection with the same pump and motor is frequently used with the view of eliminating heavy suspension and cuticle which may adhere to the bottom of the pool and not be readily carried off by the general circulation. In many cases the hot water tank is eliminated and an automatic water heater is used with automatic gas attachment.

The systems which we have made a thorough and complete investigation on have been equipped with a most thorough and up-to-date apparatus, which is the Everson filter equipment. Illustrations of the pool shown herein has the very finest equipment possible to obtain. The water is filtered so thoroughly that it will magnify to such an extent that the pool does not look to be more than a foot deep, whereas in reality it is over 8 feet in depth.

Elevation and Drainage of Swimming Pools



These Illustrations Also Show Construction of Filters. Water May Circulate Through the Filter or Direct from Mains to Swimming Pool



Finished Installation

The Art of Soldering.

The term "soldering" is generally applied when fusible alloys of lead and tin are employed for uniting metals. When hard metals, which melt only above a red heat, such as copper, brass or silver are used, the term "brazing" is sometimes used.

Hard soldering is the art of soldering or uniting two (2) metals or two (2) pieces of the same metal together by means of a metal or solder that is almost as hard and infusible as the metal to be united In some cases the metals to be united are heated and their surface united without solder by fluxing the surface of the metals. This process is then termed "burning together."

Some of the hard soldering processes are often termed "brazing." Both brazing and hard soldering are usually done in the open fire or with a brazing torch. A soldering joint is more perfect and more tenacious as the point of fusion of the solder rises.

Thus: Tin, which greatly increases the fusibility of its alloys, should not be used for solder, except when a very easy running solder is wanted. Solder made with tin is not so malleable and tenacious as those prepared without it. The Egyptians soldered with lead as long ago as B. C. 1490, the time of Moses.

Pliny refers to the art, and says it requires the addition of tin to use as solder.

Another solder, a very odd but very good one for some purposes, called "Cold Solder" is as follows:

Steel Filings	2 oz.
Brass Filings	2 oz.
Fluric Acid	1¼ oz.

Dissolve the filings in the acid, apply to the parts to be soldered, having first cleaned the parts to be connected, keep the acid in a lead vessel only.

Advantage may be taken of the varying degrees of fusibility of solders to make several joints in the same piece of work. Thus, if the first joint has been made with the fine tinner's solder, there would be no danger of melting it in making a joint near it with bismuth solder.

The fusibility of soft solder is increased by adding bismuth to the composition. An alloy of lead, 4 parts, tin 4 parts and bismuth 1 part, is easily melted, but this alloy may itself be soldered with an alloy of lead 2 parts, bismuth 2 parts, and tin 1 part. By adding mercury with 2 parts of tin will make a composition which melts at 122 degrees Fahr., or taken in this order for the same work.

First	1 tin	2 lead		
Next	1 tin	1 lead		
Next	4 tin	4 lead	1 bismuth	
Next	2 lead	1 tin	2 bismuth	
Next	1 lead	1 bismuth	1 mercury	2 tin
Next	3 lead	3 bismuth	5 tin	
Next	5 lead	8 bismuth	3 tin	

Solders.

To solder lead	1 tin	2 lead
To solder tin	1 tin	1 lead
To solder pewter	2 tin	1 lead

Spelters.

for brazing:

Spelter	Hardest	3 copper	1 zinc	
Spelter	Hard	1 copper	1 zinc	
Spelter	Soft	4 copper	3 zinc	1 tin
Spelter	Very Soft	1 antimony		2 tin

Spelter ....For Platina is Gold.

Spelter for gold; 2 parts gold, 1 part silver, 1 part copper.

Spelter for silver; 4 parts silver, 3 parts brass, 1/16 part zinc.

Spelter for iron (hard); silver solder, 7 parts brass, 1 part zinc.

Spelter for iron (soft); 1 part tin, 1 part lead.

Spelter for brass and copper (hard); brass mixed with ½ to 1/5 or ½ of zinc.

Spelter for brass and copper (soft); 1 part tin, 1 part lead.

Spelter for pure tin; 4 parts pewter, 1 tin, 1 bismuth.

Spelter for very soft solder; 3 parts bismuth, 3 lead, 5 tin.

Metal which melts at a heat not exceeding boiling water is 8 parts bismuth, 5 lead and 3 of tin.

An Old but Exceedingly Good Method of Lead Burning.

The apparatus required is a cast-iron furnace, two or three ladles, and some moulding sand. Burning is resorted to by plumbers generally for purposes where soldering will not stand.

Cast a sheet of lead of the proper thickness, and cut the proper length and width, turn it up round like a hoop, bringing the two ends well together to form a good joint on the outside, and firmly tack them together on the inside; roll it over to see that the joint is close on the outside, and paste a piece of stout brown paper about 4 inches wide over the whole length of the joint.

The sand must be well tempered, not to have any wet lumps in it; make a level bed with the sand about 5 or 6 inches thick; roll the hoop on the sand so that the joint will come under, be careful not to shift it backwards or forwards, but well ram up under both sides. Have a strip of wood rather longer than the joint, and ¾-inch thick, to form the runner with, place it along on edge on the top of the joint; now place some sand both sides and ram it well together,

adding sand until there is a good bank on the top of the work; smooth it off with a trowel, cut it down towards the strip, so as to form a sort of funnel, leaving about 2 inches of the strip buried; draw out the strip endways, being careful not to break the sand, leaving one end stopped up, the other end stopped up about one inch high. At this end make a bay or pond for the overflow metal to run into. Have the metal red hot, be careful that the runner is free from loose sand, shake a little powdered rosin along the runner. Now begin to pour the metal, holding the ladle at least one foot above the runner so as to give weight and force to the burning metal; pour plenty, not minding what is running off, as the metal that is pouring in has to melt the part which is in the cold sand. When the joint is burned through try it by drawing the trying stick along in the runner; if it feels smooth along the bottom it is burned, if not, pour some more until it is, then stop up the end where the metal has been running off, and fill up about two inches high, and watch for shrinkage, having some hot metal ready to fill up as it shrinks down in cooling, or else the joint will not be round. When set, remove it from the sand, and cut off the runner with a mallet and chisel, finishing off with a piece of card wire, the paper on the outside will strip off, leaving it bright and clean.

Having now completed this part and set it up, round in shape, proceed with burning in the bottom; having a hole or pit in the floor, deep enough for the hoop to go down level with the floor, placing it in perfectly level. Fill up with the sand inside and out rather slackly. When filled up within four or five inches from the top, ram it down for the other part quite hard on the outside, leaving the sand rather higher than the edge; then with a straightedge scrape off level with the edge of the lead. Now with a scribe

take out the sand the thickness of the required bottom, plane the sand off with a trowel, and the work will turn out clean. The sand on the outside being up level with the edge, smooth off, and cut a bay all around to take the overflow, shake a little rosin around the edge; having the metal red hot, begin to pour as before, only this is a work for two or three persons if it is any size, as it must be done quickly, pouring the metal along the edge until it is properly burned down; when it is burned deep enough, pour a few ladlefuls all over the bottom, so as to get in a thoroughly fluid state; then with the edge of the trowel clean off the dross, leaving a perfectly bright surface. Let it remain to set. This will not require any filling up, as it is open to the air and shrinks; when set it may be removed, and if well burned it will be perfectly solid.

Heating Liquids by Steam.

In the design of a heater for water and other liquids, the two principal factors are the proper admission of steam and the rapid elimination of the condensation.

On the opposite page I call your attention to the Russell instantaneous heater for the heating of water for all kinds of commercial purposes. These heaters are made in the single compound and storage type. The shell and heads are of the best cast gray iron; the heating tubes are of wrought iron or seamless brass. The admission of the cold water and the delivery of the heated water are so arranged that same must come in contact with the entire tube surface.

In the compound heater, as illustrated, and which was designed for 10,000 gallons of water per hour from an initial temperature of 50 degrees to a terminal temperature of 185 degrees, 1¾-inch seamless brass tubes were used. Each tube had a separate ½-inch steam supply which delivered the steam to the extreme end of tubes before delivery to the 1¾-inch tubes. By this arrangement the water of condensation has but 6 feet to travel to reach condensation chamber provided in the heater.

The rapid delivery of the condensed water from the tubes renders the tube surface 96 per cent efficient. This construction gives the high heat transmission claimed and delivered by the Russell design.

So little is known by the average engineer and users of heaters regarding the amount of heating surface required; the B. T. U. transmission per square foot of surface; the pounds of steam condensed and other factors, that I insert a chart on an adjoining page which will enable engineers, heating contractors and users of heaters to figure out requirements.

The accompanying chart shows the relative efficiency of iron and brass pipe when used in storage heaters.

The following explains how to use the chart: First determine the number of pounds of steam required per hour to transmit the necessary number of heat units to raise the water to desired temperature.

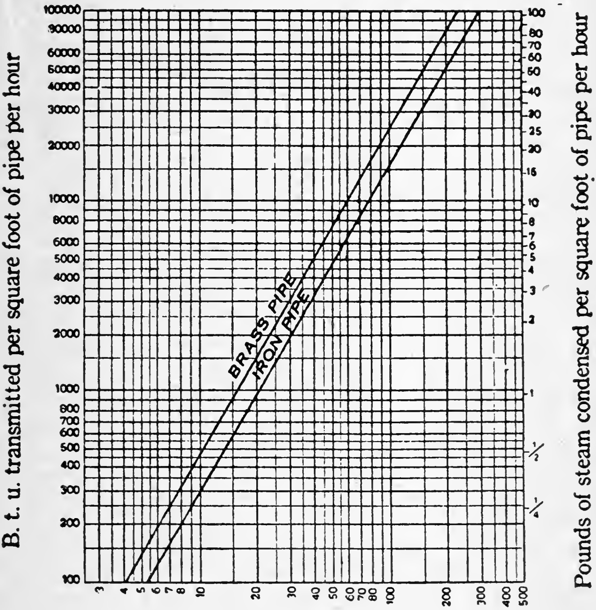
For example: The temperature of steam in pipes is 220 degrees; the initial temperature of the water is 50 degrees; the terminal temperature of the water is 190 degrees; thus the mean temperature of the water is 120 degrees. The difference in temperature of steam and water is 100 degrees.

On the bottom of chart you will note the difference

Heating Power of Brass and Iron Pipe

For Water Storage Tanks

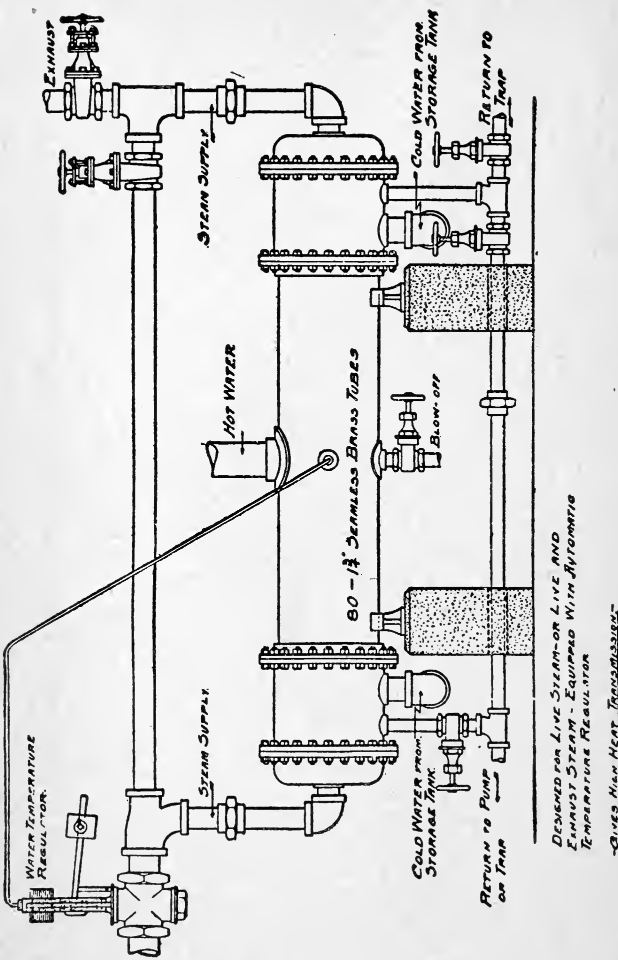
For use with Low Pressure Steam, up to 10 pounds by gauge. A "factor of safety" of 50% is included, to allow for fouling of pipe.



Temperature difference in Fahr degrees between steam in coil and mean or average temp. of water in tank

in temperature, in Fahr. degrees, between the steam in the coil and the average temperature of water in the tank.

Follow the line marked 100 degrees upward to where it intersects with iron pipe line, then to the right to edge of chart marked 15. This indicates that 15 pounds of steam is condensed per hour per square foot of pipe. The required quantity of heating surface in square feet is determined by dividing the number of pounds of steam which must be condensed per hour by the number of pounds one square foot of pipe or heating surface will condense in one hour.



The best type of heater ever invented for heating water to a high temperature in an economical manner for boiler feed and domestic use.

Thus: (Iron pipe) 1,000, which is the number of pounds of steam to be condensed per hour, divided by 15 equals 66⅔, or the number of square feet of pipe or heating surface required. On the same line of the chart at left margin you will note that 15,000 is the number of B. T. U. transmitted per square feet of pipe or heating surface per hour.

Hot Water for Domestic Purposes.

In the accompanying sketches is shown the correct method of installing the piping for hot water for domestic uses. In work of this kind, the pipes must always have a general upward pitch to the boiler, or tank. Care must be taken that there are no dips or traps, as this will cause hammering and pounding in the system. Sediment or draw off cocks must be placed at the lowest point, in order to thoroughly drain the system. Stops and check valves should not be used at all in this work, excepting, of course, the stop and waste on the cold water supply to the boiler. A vent should always be provided to allow for the expansion, in all cases where the expansion cannot "blow back" into the water main. In cases where the supply is taken from a tank in the attic, an expansion pipe should be run above the tank as shown in Fig. 64. Fig. 56 shows connection between gas range and boiler, and Fig. 57 connection between coal range and boiler. Fig. 58 shows range boiler connected to two ranges in the kitchen, and to two heaters in the basement. In work of this kind, care should be taken to place the boiler above the source of heat; for instance; a boiler in the basement should never be connected to a range on the first floor, because were the water to be shut off, the water front would drain. If the

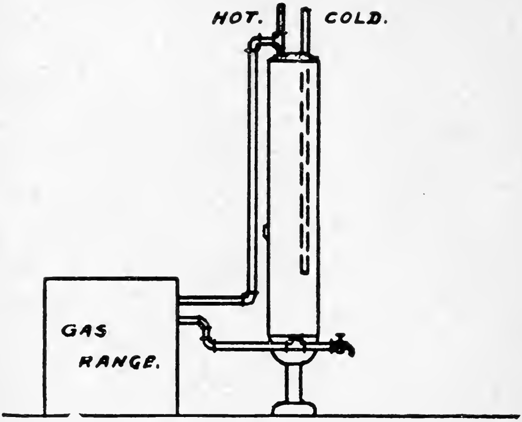


Fig. 56.

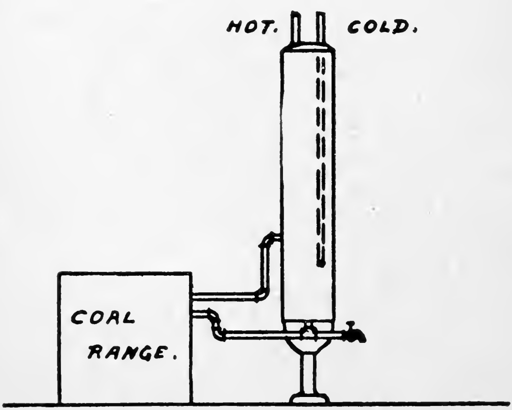


Fig. 57.

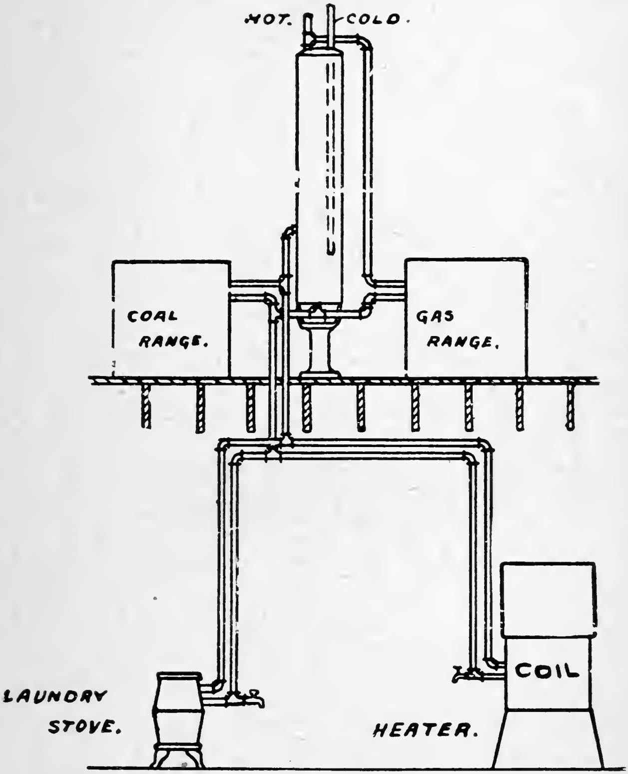


Fig. 58.

water were then turned on, the cold water entering the hot water front, would generate steam so quickly, that it would in all probability blow up the water front. With the boiler in its proper place, that is, above the source of heat, the shutting off of the water would have no effect on the boiler or water front, as water would still remain in the boiler to within six inches of the top. Figs. 59, 60, and 61, show the connections between tanks and tank heaters. Fig. 62 shows the method of installing the hot water piping to the fixtures in an ordinary dwelling, the hot water being taken from a hot water tank in

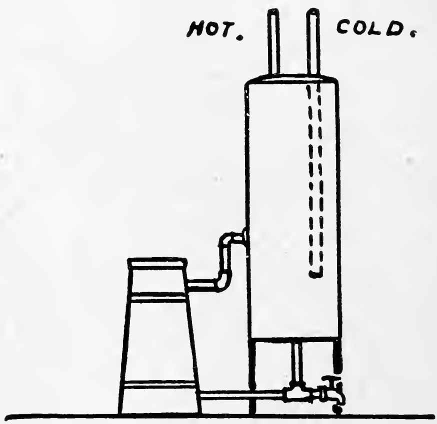
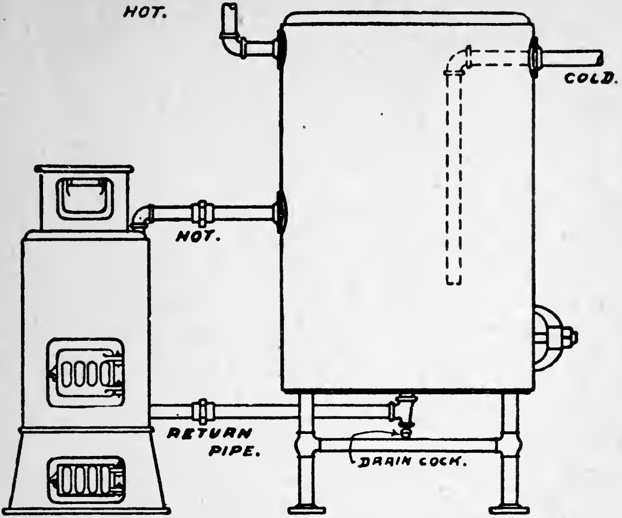


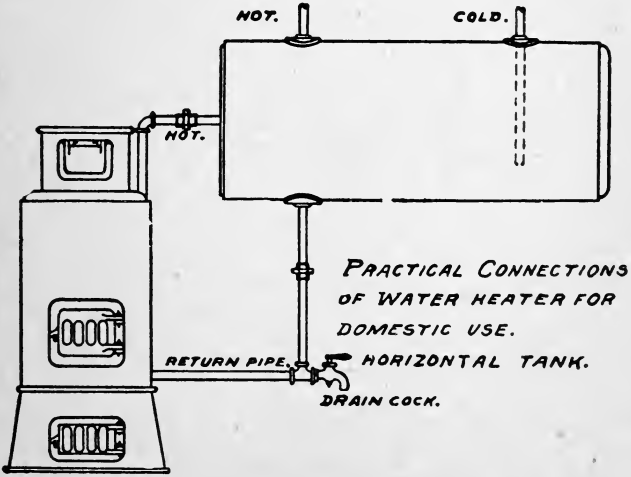
Fig. 59.

the basement, and a circulating pipe brought back to the heater. The hot water is taken from the top of the tank and carried to the highest fixture. A return pipe is carried from this point and connection made to cold water supply to heater, as close to heater as possible. The hot water for all fixtures, except the highest, is taken from the return pipe, as shown in sketch. For hotel work, it is a good plan to carry the hot water direct to the attic, and from there dis-



PRACTICAL CONNECTIONS OF WATER HEATER FOR DOMESTIC USE.
VERTICAL TANK.

Fig. 60.



PRACTICAL CONNECTIONS OF WATER HEATER FOR DOMESTIC USE.
HORIZONTAL TANK.

Fig. 61.

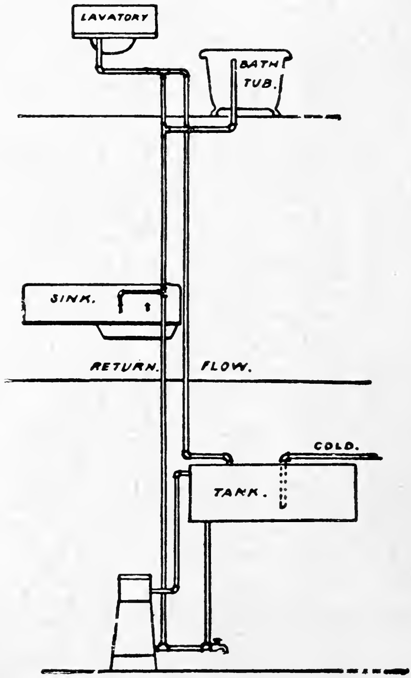


Fig. 62.

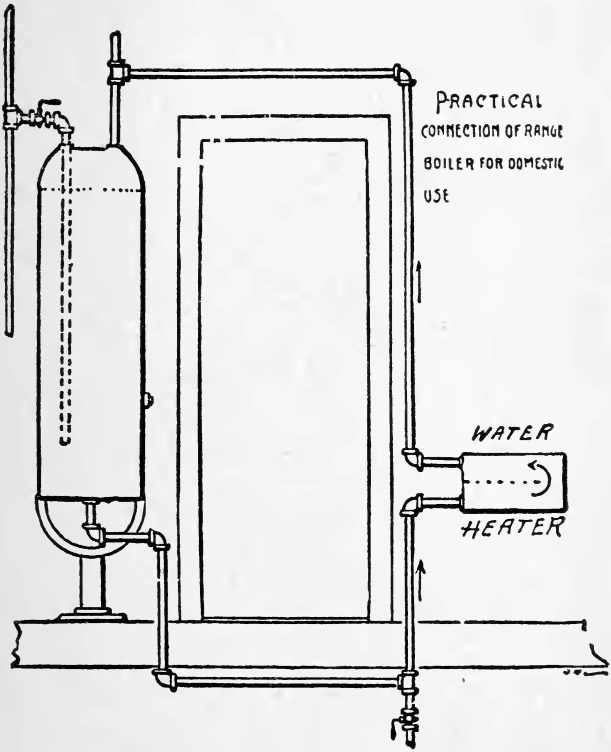

PRACTICAL
CONNECTION OF RANGE
BOILER FOR DOMESTIC
USE
WATER
HEATER

Fig. 63.

tribute it to the fixtures through the return risers. In Fig. 63 is shown the connection between range and boiler in cases where a door or window intervenes between boiler and range. A great deal of trouble is often caused from work installed as shown in Fig. 64. The hot water pipe is taken from the boiler and carried under the floor to a sink on the same floor, this sink being the highest fixture from which hot water is drawn. At times, the hot water will run freely from the sink faucet, then suddenly stop, although the faucet remains open. The trouble will be found at the point marked "X." To prevent this trouble, a vent must be carried as shown in the dotted line. This vent may be of ⅜" galv. pipe, and should be carried above the tank, and turned down, the end remaining open above the water line. In cases where this vent or expansion pipe cannot be installed, put a small pet cock at the point marked "X." In case of stoppage of the hot water, this pet cock should be opened for a few moments and trouble will cease.

Pump Systems.

In Fig. 65 is shown the complete hot and cold piping for a dwelling, in which the supply is pumped to a tank in the attic. The supply to tank from pump is also used for the cold supply to all fixtures. This supply enters the tank at the bottom, and at this point, in the tank, is placed a Tee with a check valve to prevent the water from entering the tank. The ball cock should be connected to the top of the Tee. An overflow should be taken from the tank and discharged to the nearest convenient place. A pressure gauge should be placed near the pump to show when system is filled.

In Fig. 66. is shown the method of installing a soft water system, using the city pressure for power to run the water lift. In work of this kind a faucet

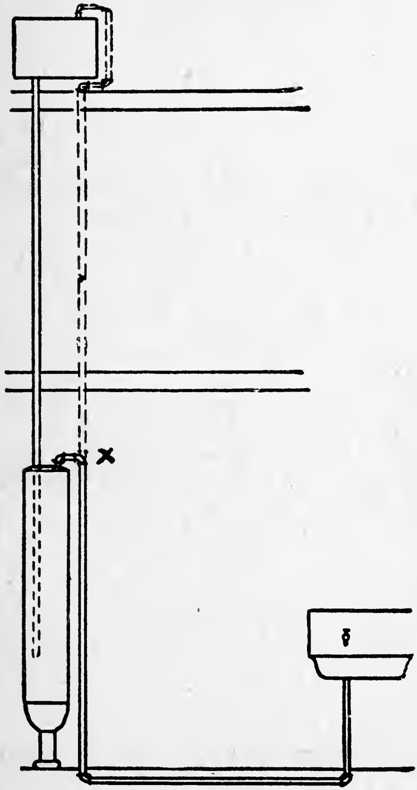


Fig. 64.

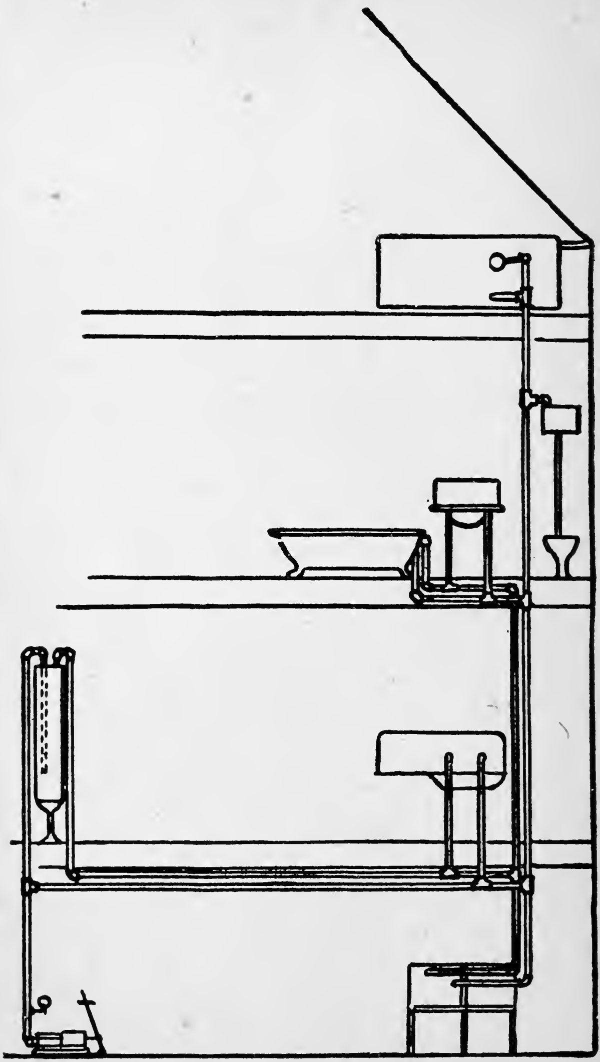


Fig. 65.

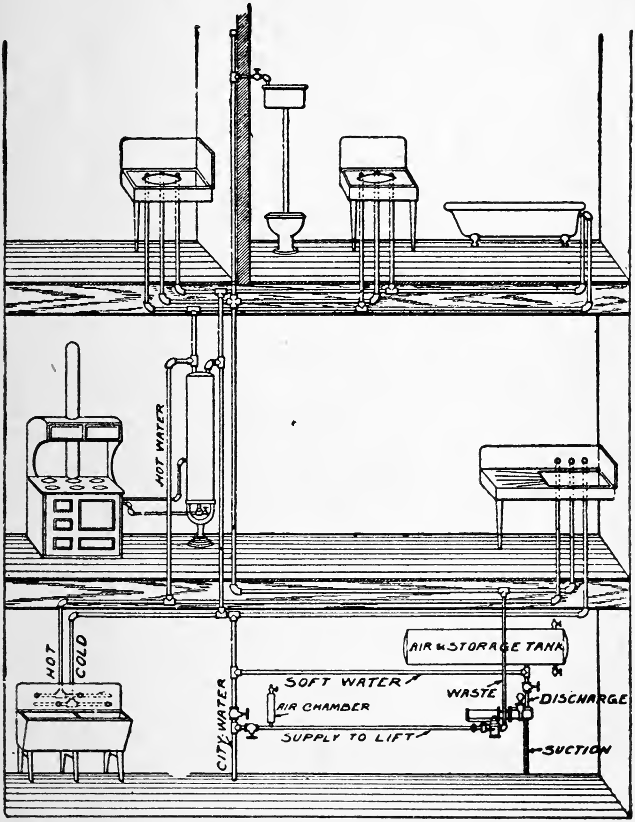
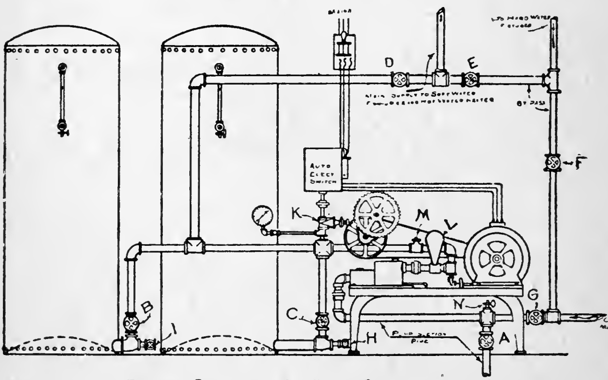

HOT WATER
HOT
COLD
CITY WATER
AIR & STORAGE TANK
SOFT WATER
WASTE
DISCHARGE
AIR CHAMBER
SUPPLY TO LIFT
SUCTION

Fig. 66

for city water for drinking purposes is generally placed at each fixture, and the city water also supplies the water closet tanks. In this way the water used for power to run the water lift, is used instead of being wasted into the sewer. A storage tank should be placed in the attic with an over-flow, either directly back to the cistern, or out through the roof. The pipes in the basement should be so cross-connected as to by-pass the city water into the system in case of shortage of soft water.

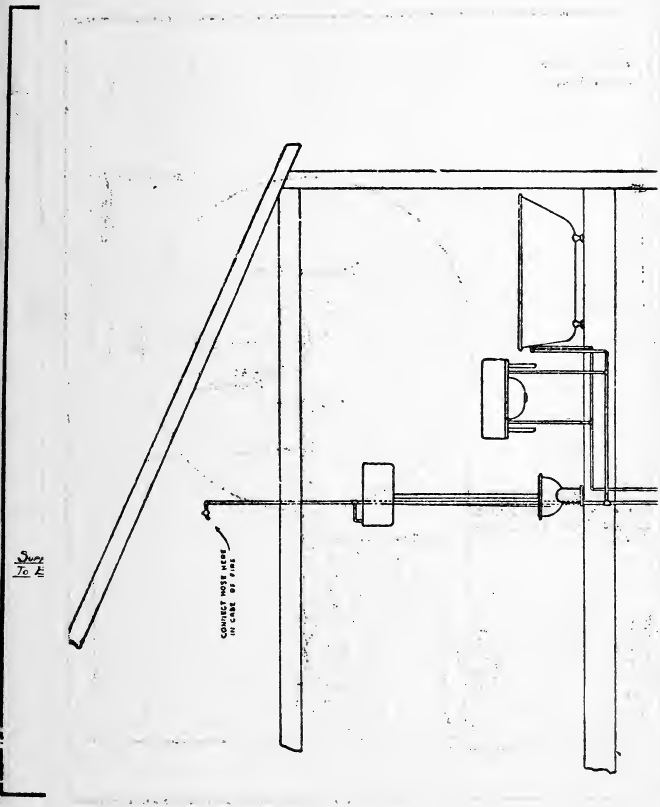
Pneumatic Water Supply Systems.

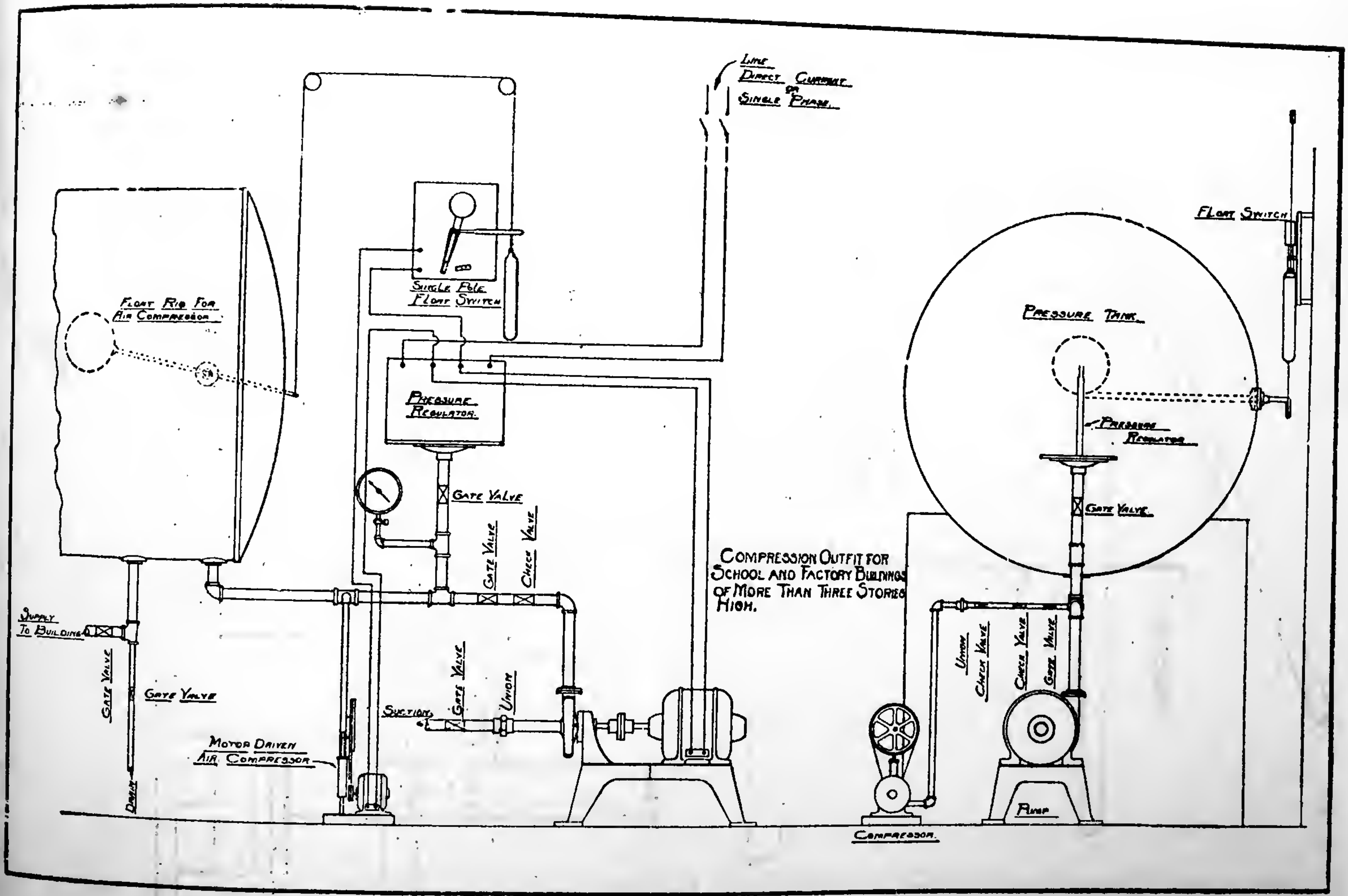
In Fig. 67 is shown the method of installing the pneumatic water system which is coming into general use for farm houses, and in fact, is now being used to maintain pressure in municipal water plants.



AUTOMATIC ELECTRIC RAINWATER COMPRESSION TANK PUMPING SYSTEM.

A—SUPPLY FROM CISTERN.
B & C—VALVES TO EITHER TANK CAN BE USED.
D—FOR SOFT WATER TO FIXTURES.
E—FOR CITY WATER TO SOFT WATER PIPE.
F—CITY SUPPLY TO FIXTURES.
G—CITY SUPPLY TO PUMP.
H & I—DRAW OFF COCKS.
K—VALVE TO CONTROL AUTOMATIC SWITCH.
L—AIR CHAMBER.
M—CHECK VALVE TO STOP WATER FROM BACKING UP TO PUMP.
N—AIR COCK TO LET OUT AIR.


CONNECT HOSE HERE
IN CASE OF FIRE


LINE
DIRECT CURRENT
OR
SINGLE PHASE.
FLOAT RIG FOR
AIR COMPRESSOR
SINGLE POLE
FLOAT SWITCH
PRESSURE
REGULATOR.
GATE VALVE
GATE VALVE
CHECK VALVE
COMPRESSION OUTFIT FOR
SCHOOL AND FACTORY BUILDINGS
OF MORE THAN THREE STORIES
HIGH.
SUPPLY
TO BUILDING
GATE VALVE
GATE VALVE
DRAIN
MOTOR DRIVEN
AIR COMPRESSOR
SUCTION
GATE VALVE
UNION
FLOAT SWITCH
PRESSURE TANK.
PRESSURE
REGULATOR
GATE VALVE
UNION
CHECK VALVE
CHECK VALVE
GATE VALVE
COMPRESSOR.
PUMP

fo
pl
pl
us
of
sh
ei
rc
cc
te

pi
e:
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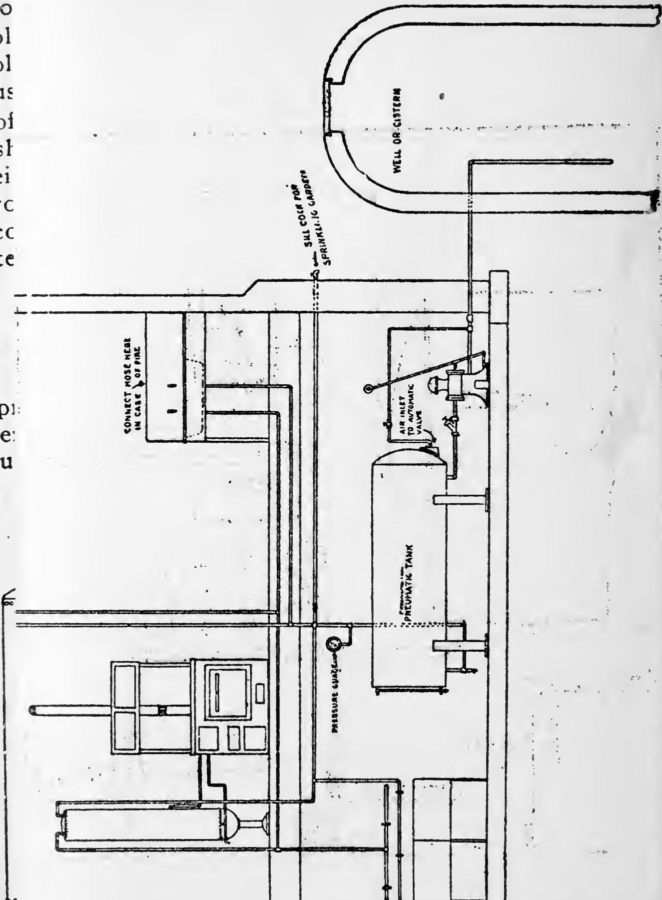
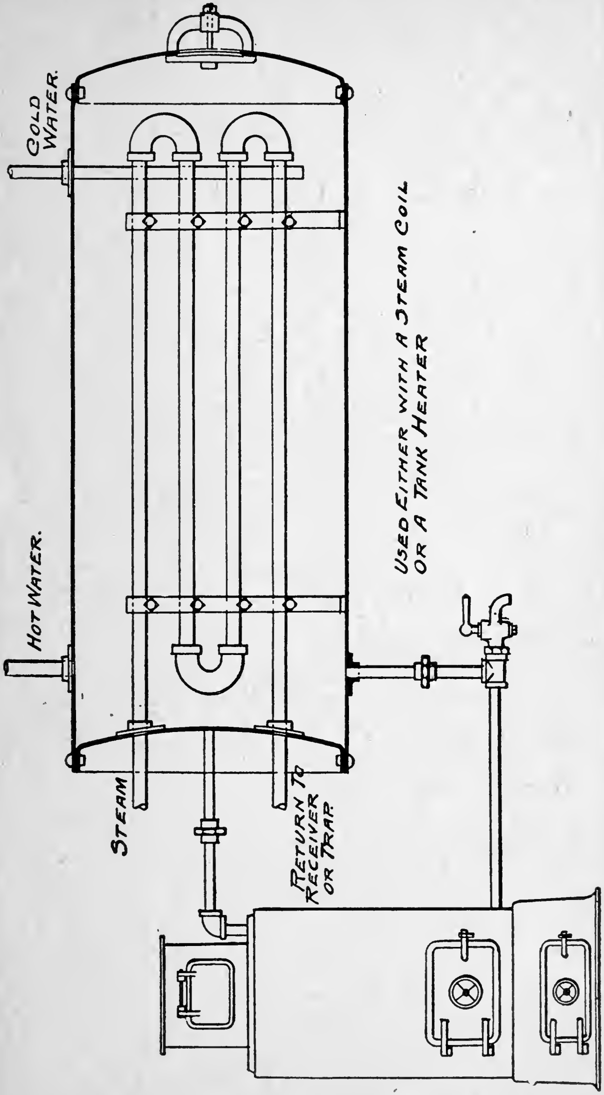


Fig. 67



This is the proper way to build a coil to be installed in a tank, for domestic use

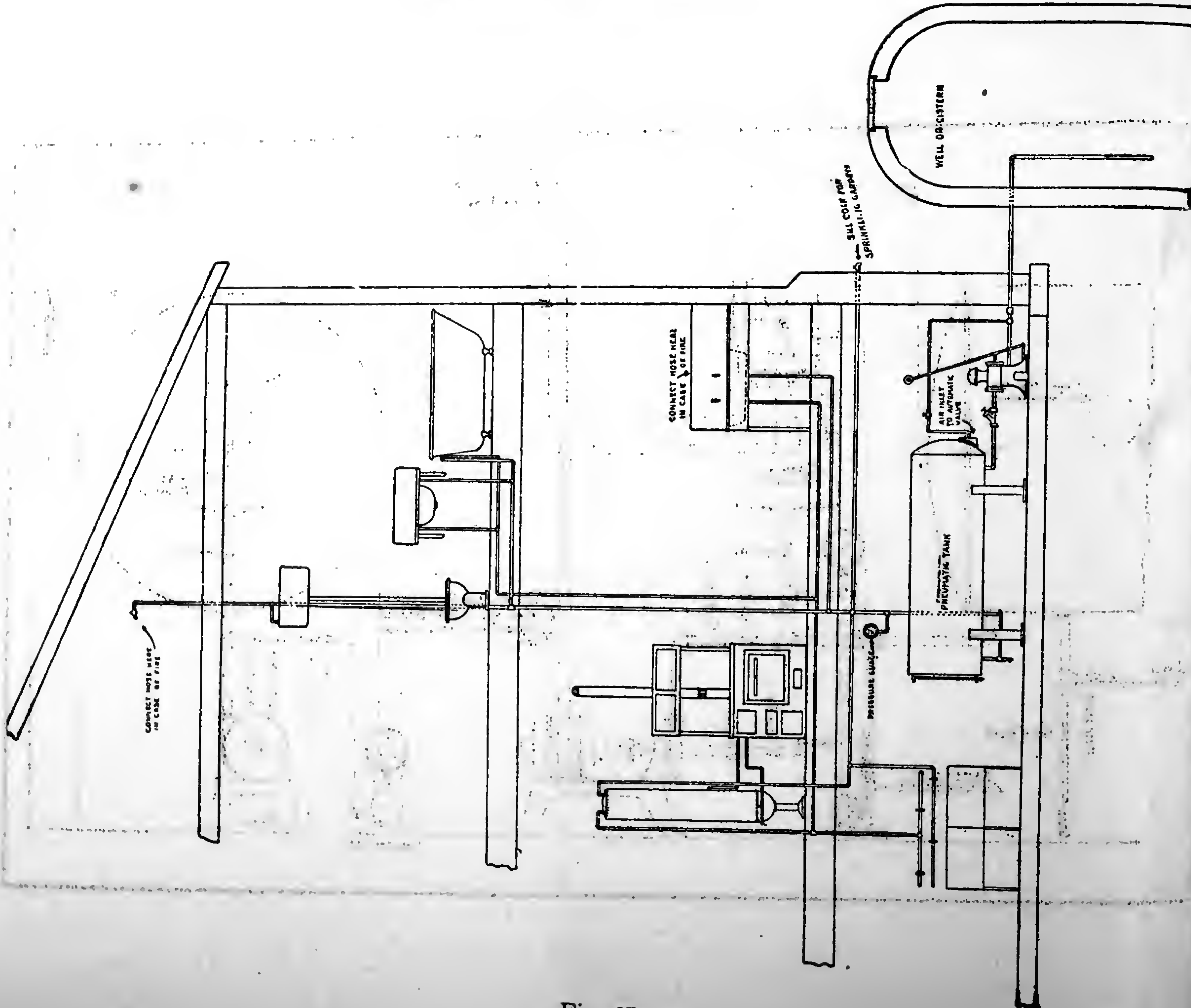
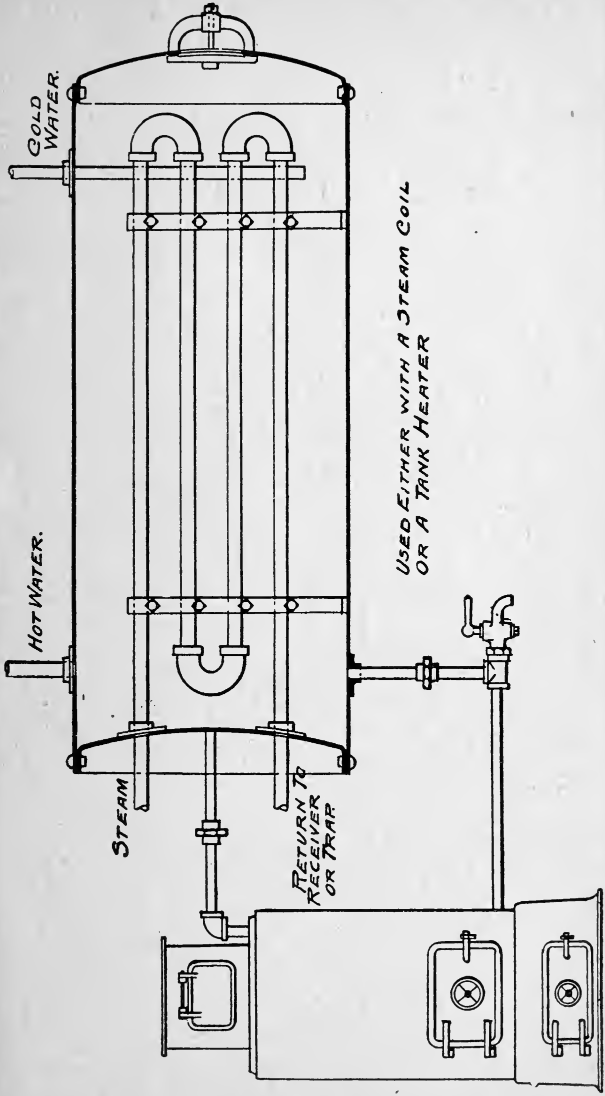
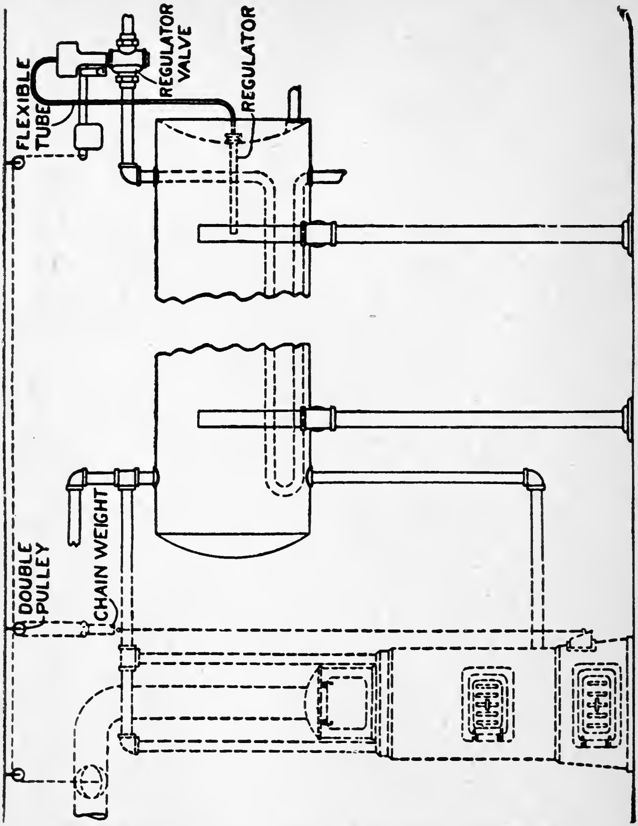

WELL OR CISTERN
SILL COCK FOR SPRINKLING GARDEN
CONNECT HOSE HERE IN CASE OF FIRE
AIR INLET TO AUTOMATIC VALVE
PNEUMATIC TANK
PRESSURE GUAGE
CONNECT HOSE HERE IN CASE OF FIRE

Fig. 67



This is the proper way to build a coil to be installed in a tank, for domestic use

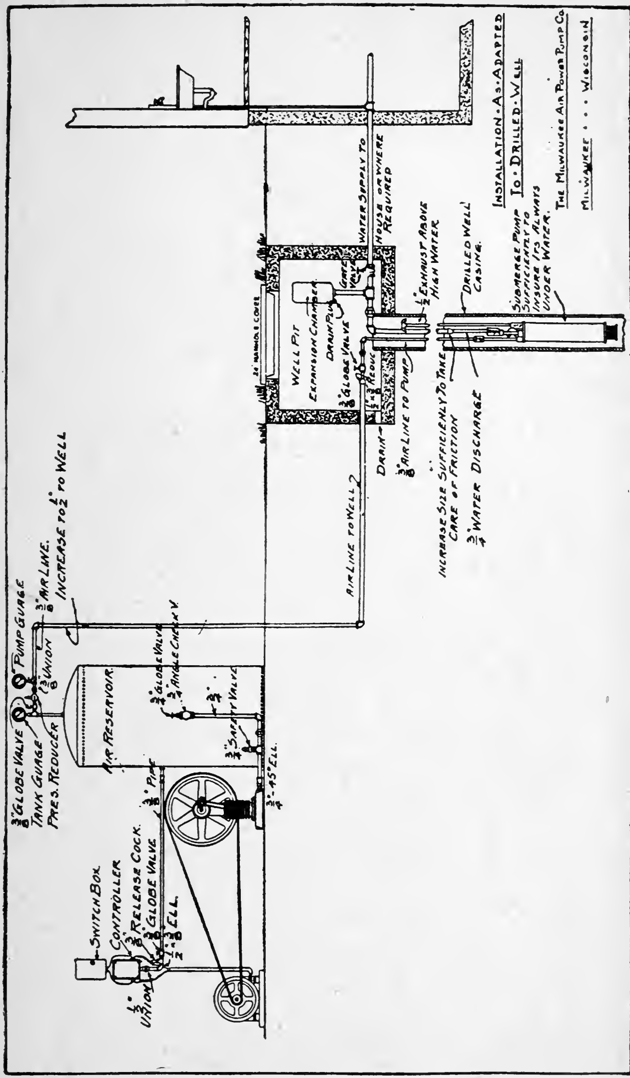


Illustrating Powers Hot Water Regulator.

DEEP WELL PNEUMATIC SYSTEM

"The drawing on the following page shows the installation of a Milwaukee Air Power Direct from the Well Water System. The tank contains air only which is conducted from the tank to the well through small air lines, where a pneumatic air power pump is located. The water is then piped direct from the pump to the fixtures.

"This plant is automatic in operation as the pump in the well works only when the faucet is open and the electric motor starts and stops automatically when more pressure in the tank is required.



"With this equipment the power to deliver the water is compressed air and is stored in the tank instead of water."

Pressure for Different Heads of Water at 62 Degrees Fah.

1 Foot head = 0.43302 lb. per sq. in. 1 inch head = 0.5774 ounces per sq. in.

Inches of Water to Ounces Per Square Inch.

Head, inches.....	1	2	3	4	5	6	7	8	9	10	11	12
Pressure, inches.	.577	1.15	1.73	2.31	2.89	3.46	4.04	4.62	5.20	5.77	6.35	6.93

Feet of Water to Pounds Per Square Inch

Head, feet	0	1	2	3	4	5	6	7	8	9
0	....	0.433	0.866	1.299	1.732	2.165	2.598	3.031	3.464	3.897
10	4.330	4.763	5.196	5.629	6.062	6.495	6.928	7.361	7.794	8.227
20	8.660	9.093	9.526	9.959	10.392	10.825	11.258	11.691	12.124	12.557
30	12.990	13.423	13.856	14.289	14.722	15.155	15.588	16.021	16.454	16.887
40	17.320	17.753	18.186	18.619	19.052	19.485	19.918	20.351	20.784	21.217
50	21.650	22.083	22.516	22.949	23.382	23.815	24.248	24.681	25.114	25.547
60	25.980	26.413	26.846	27.279	27.712	28.145	28.578	29.011	29.444	29.877
70	30.310	30.743	31.176	31.609	32.042	32.475	32.908	33.341	33.774	34.207
80	34.640	35.073	35.506	35.939	36.372	36.805	37.238	37.671	38.104	38.537
90	38.970	39.403	39.836	40.269	40.702	41.135	41.568	42.001	42.436	42.867

Example: For head of 18 ft., pressure is 7.794 lbs. per sq. in.

Tank Capacity.

Diameter.	Gallons per Foot of Depth.
2 feet	23.5
2 feet 6 inch	36.7
3 feet	52.9
3 feet 6 inch	72.0
4 feet	94.0
4 feet 6 inch	119.0
5 feet	146.9
5 feet 6 inch	177.7
6 feet	221.5
6 feet 6 inch	248.2
7 feet	287.9
7 feet 6 inch	330.5
8 feet	376.0
8 feet 6 inch	424.5
9 feet	475.9
9 feet 6 inch	530.2
10 feet	587.5
11 feet	710.9
12 feet	846.0
13 feet	992.0
14 feet	1151.5
15 feet	1321.9
20 feet	2350.1
25 feet	3672.0
30 feet	5287.7
35 feet	7197.1
40 feet	9400.3

Vertical and Horizontal Tank.

Capacity, Gallons.	Diameter, Inches.	Length, Feet.	Approximate Weight.
66	18	5	220
85	20	5	250
100	22	5	280
120	24	5	320
145	24	6	360
170	24	7	400
180	30	5	480
215	30	6	540
250	30	7	590
300	30	8	640
325	36	6	780
365	36	7	810
420	36	8	880
430	42	6	1150
575	42	8	1400
720	42	10	1650

Air and Water Pressure Tanks.

Diameter, Feet.	Length Feet.	THICKNESS.		Weight.	Capacity, Gallons.
		Shell.	Heads.		
5	20	5/16	3/8	6250	2922
5	25	5/16	3/8	7390	3654
5	30	5/16	3/8	8580	4384
6	20	5/16	1/2	7800	4240
6	28	5/16	1/2	10200	5936
6	36	5/16	1/2	12450	7632
7	20	5/16	1/2	8600	5761
7	28	5/16	1/2	11100	8066
7	36	5/16	1/2	13600	10370
8	24	5/16	1/2	11800	8980
8	30	5/16	1/2	14000	11224
8	36	5/16	1/2	16200	13468

Air and Water Pressure Tanks.

Diameter, Inches.	Length Feet.	Weight	Capacity, Gallons.
24	6	350	140
24	8	420	190
24	10	500	235
30	6	530	220
30	8	650	295
30	10	770	365
30	12	900	440
30	14	1000	515
36	6	750	315
36	8	900	420
36	10	1050	525
36	12	1200	630
36	14	1400	735
36	16	1575	840
42	8	1450	575
42	10	1650	720
42	12	1900	865
42	14	2200	1000
42	16	2400	1150
42	18	2650	1300
42	20	2900	1440
48	10	2200	940
48	12	2550	1130
48	14	2900	1300
48	16	3250	1500
48	18	3600	1700
48	20	3950	1880
48	24	4650	2260

Number of U.S. Gallons in Rectangular Tanks—For one foot in depth

Width of Tank	LENGTH OF TANK.																				
	2 ft.	2 ft. 6 in.	3 ft.	3 ft. 6 in.	4 ft.	4 ft. 6 in.	5 ft.	5 ft. 6 in.	6 ft.	6 ft. 6 in.	7 ft.	7 ft. 6 in.	8 ft.	8 ft. 6 in.	9 ft.	9 ft. 6 in.	10 ft.	10 ft. 6 in.	11 ft.	11 ft. 6 in.	12 ft.
2 ft.	30	37	45	52	60	67	75	82	90	97	105	112	120	127	135	142	150	157	165	172	180
2 ft. 6 in.	....	47	56	65	75	84	94	103	112	122	131	140	150	159	168	178	187	196	206	215	224
3 ft.	....	....	67	79	90	101	112	123	135	146	157	168	180	191	203	213	224	236	247	258	269
3 ft. 6 in.	....	....	....	92	105	118	131	144	157	170	183	196	209	223	236	249	262	275	288	301	314
4 ft.	....	....	....	....	120	135	150	165	180	194	209	224	239	254	269	284	299	314	329	344	359
4 ft. 6 in.	....	....	....	....	....	151	168	185	202	219	236	252	269	286	303	320	337	353	370	387	404
5 ft.	....	....	....	....	....	....	187	206	224	243	262	281	299	318	337	355	374	393	411	430	449
5 ft. 6 in.	....	....	....	....	....	....	....	226	247	267	288	309	329	350	370	391	411	432	453	473	494
6 ft.	....	....	....	....	....	....	....	....	269	292	314	337	359	381	404	426	449	471	494	516	539
6 ft. 6 in.	....	....	....	....	....	....	....	....	....	316	340	365	389	413	438	462	486	511	535	559	583
7 ft.	....	....	....	....	....	....	....	....	....	....	367	393	419	445	471	497	524	550	576	602	628
7 ft. 6 in.	....	....	....	....	....	....	....	....	....	....	....	421	449	477	505	533	561	589	617	645	673
8 ft.	....	....	....	....	....	....	....	....	....	....	....	....	479	509	540	569	598	628	658	688	718
8 ft. 6 in.	....	....	....	....	....	....	....	....	....	....	....	....	....	540	572	604	636	668	699	731	763
9 ft.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	606	640	673	707	741	774	808
9 ft. 6 in.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	675	711	746	782	817	853
10 ft.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	748	785	823	860	898
10 ft. 6 in.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	825	864	903	943
11 ft.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	905	946	987
11 ft. 6 in.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	989	1032
12 ft.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1077

Combination Vent and Drainage Connections

During the last decade or two, great advancements have been made in plumbing and drainage. In fact, what was considered perfection only a few years ago, is now obsolete.

Amongst all the improvements, the so-called F & W Combination Vent, Re-vent and Drainage fittings easily take the lead. As all re-vent connections to the soil stack are connected by means of 45° and all so-called pockets are done away with. It absolutely prevents any rust or sediment to lodge in the bends and thereby, after a few years, close up the re-vent as was the case in the old style fittings. The F & W system is now considered the perfection and is compulsory in several of the largest cities in both the east and west.

"Fig. A" shows the customary way of roughing in for a two-story and basement residence having one water-closet and stationary laundry tub in the basement, kitchen sink on the first floor, water-closet, bath tub, and lavatory on second floor.

"Fig. B" shows roughing in for a two, or more, stories flat building. Here, of course, kitchen sink, bath tub, water-closet and lavatory are on one floor and roughing in repeated for as many stories as the building contains. The dotted lines, where marked "Plan of fixtures," shows a partition wall and the different fixtures.

"Fig. C" is an elevation of roughing in for a battery of double water-closets as used in schools, office buildings, factories and public buildings.

For houses in towns and country places, where there are no sewers, the soil from a full line of fixtures can be taken care of in a perfectly sanitary way by building a cess pool of either brick or wood, 25 feet or more from the rear of the building. If the cess pool is of wood, holes of 1½″ or 2″ diameter should be drilled on about 4″ or 6″ centres all the way around and for a height of three to four feet. If of brick, use good hydraulic cement mortar and leave a 2″ opening at frequent intervals and to a height slightly below the soil pipe. A run from the cess pool can be made to distribute the water over a larger area. If such a run is made, lay the pipes without any cement joints, thereby letting the water run out at every joint.

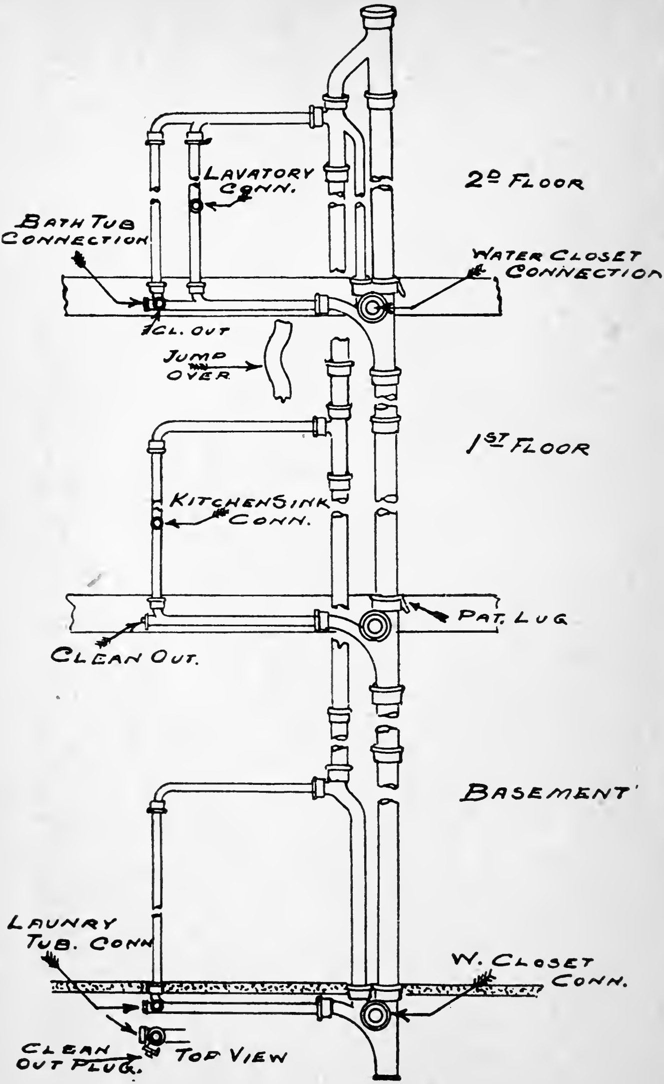

LAVATORY CONN.
2D FLOOR
BATH TUB CONNECTION
WATER CLOSET CONNECTION
CL. OUT
JUMP OVER
1ST FLOOR
KITCHEN SINK CONN.
PAT. LUG
CLEAN OUT.
BASEMENT
LAUNRY TUB. CONN
W. CLOSET CONN.
CLEAN OUT PLUG.
TOP VIEW

FIG. A.

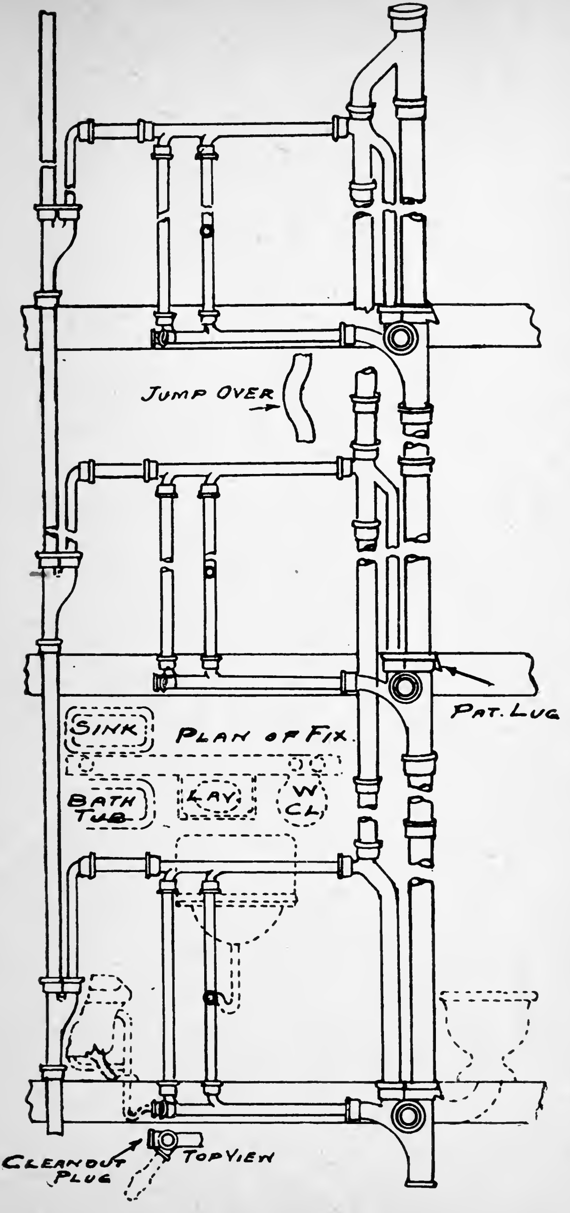

JUMP OVER
PAT. LUG
SINK
PLAN OF FIX.
BATH TUB
LAV.
W CL.
CLEANOUT PLUG
TOP VIEW

FIG. B.

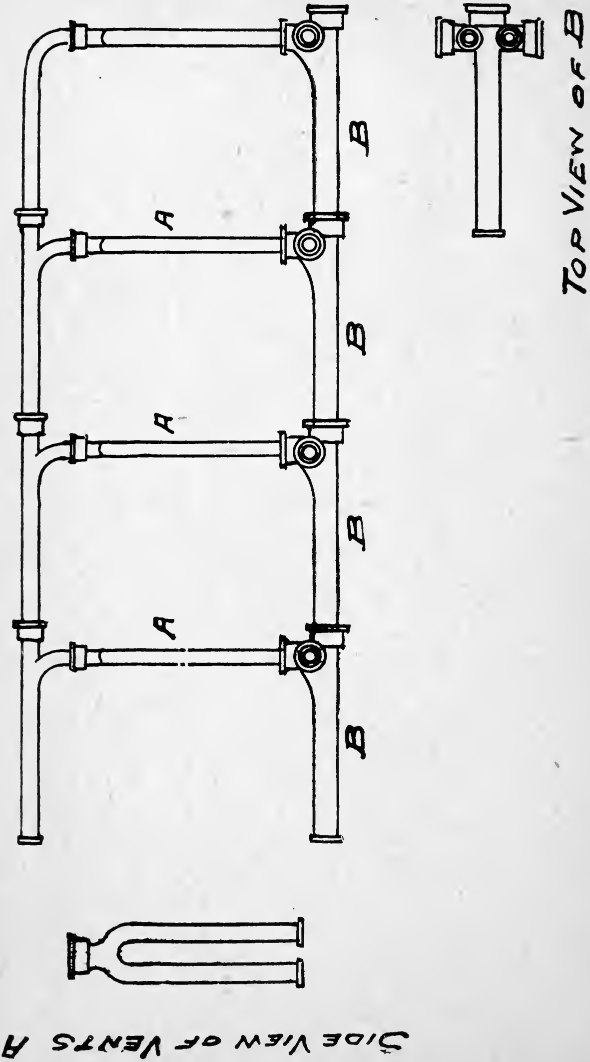
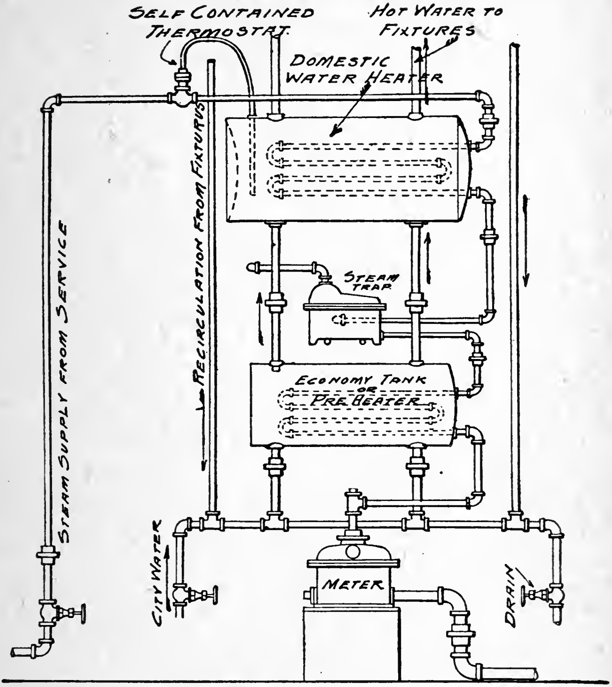
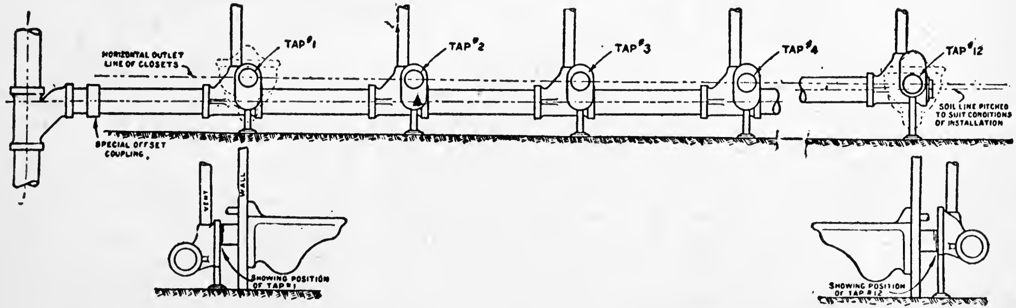


FIG. C.



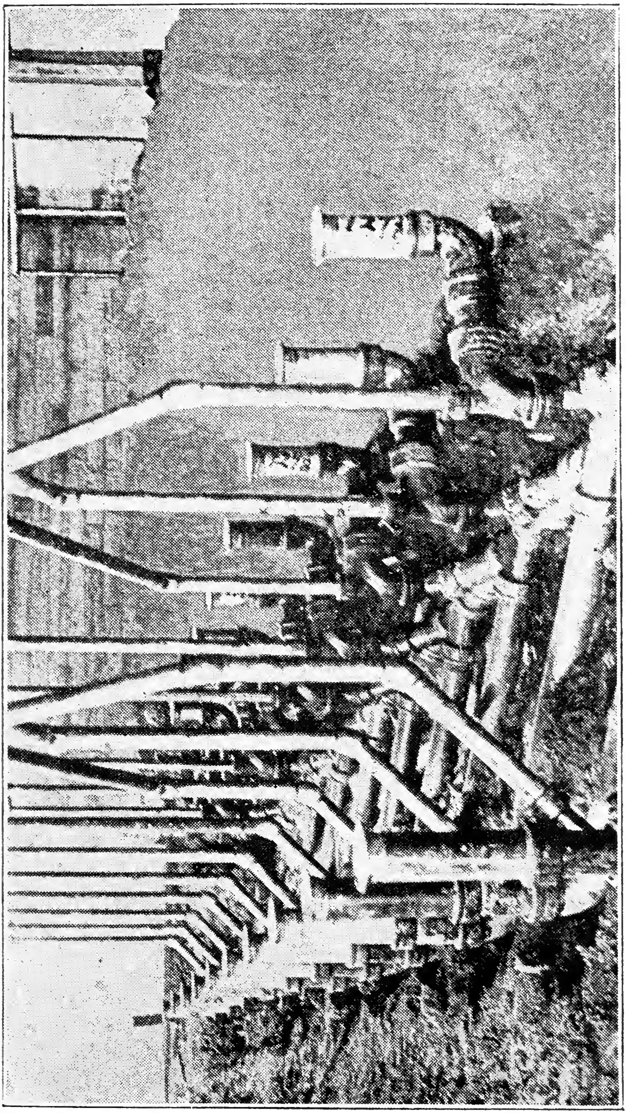
TYPICAL CONNECTION OF HOT WATER TANKS FOR DOMESTIC USE— CONNECTED TO CENTRAL HEATING PLANT.
DESIGNED BY AMERICAN DISTRICT STEAM.

GENERAL ARRANGEMENT, SHOWING AN INSTALLATION OF A BATTERY OF CLOSETS

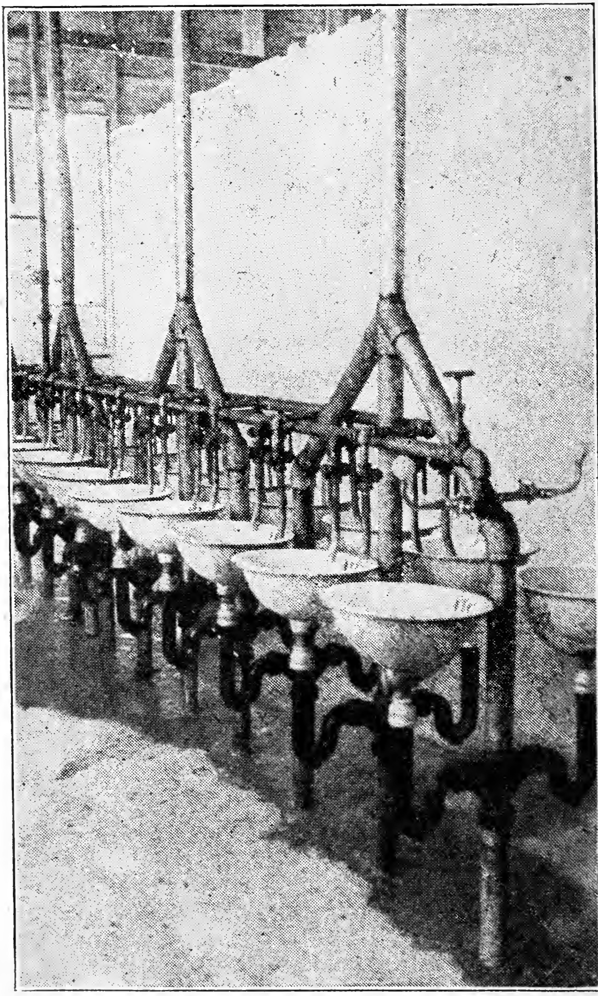


The fitting with the highest tapping position should always be installed next to the soil stack. This fitting is marked No. 1. The second one from the stack is No. 2, and so on. The fitting with the lowest tapping position is No. 12. The different tapping positions are ⅜ inch from center to center.

To get all closet seats the same distance from the floor level, also to take care of the pitch, of the soil line, we provide a special pitched coupling which should preferably be used next to the stack. By turning this coupling proper installation of the closet combinations is readily made possible.



Illustrating the method of Roughing-In as done in San Francisco, Calif. Courtesy Chief Plumbing Inspector.



Method of Roughing-In as done in San Francisco, Calif.
Courtesy Chief Plumbing Inspector.

The Sanitary-perfect Screw Connection

As Manufactured and Furnished by The J. L. Matt Iron Works of New York

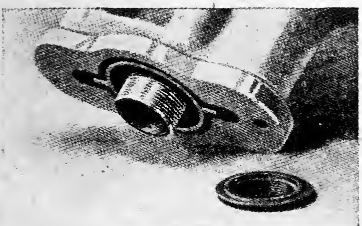


Plate 5001-A

In these days of almost perfection in sanitary science, the connection of the water closet to the soil pipe is the one weak spot in an otherwise admirable system of house plumbing, the one connection that cannot be relied upon under all conditions. That absolute security is assured, and the question of careless or unskilful work disposed of by the sanitary-perfect screw connection, must be admitted by all; moreover, those who have seen and used this devise do not hesitate to say that it solves the question of water closet connection, and state, furthermore, that knowing such device to exist they would feel in duty bound to recommend the same to their clients as the only perfect connection which they could guarantee under all conditions.

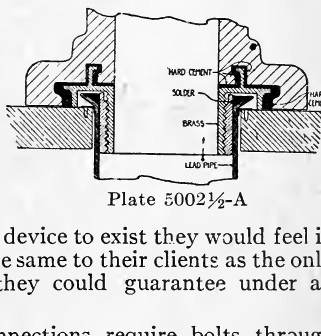


Plate 5002½-A

NOTE.—All ordinary connections require bolts through the base of the closet. The sanitary-perfect is a screw connection, hence is absolutely and permanently reliable and furthermore it dispenses with unsightly bolts.

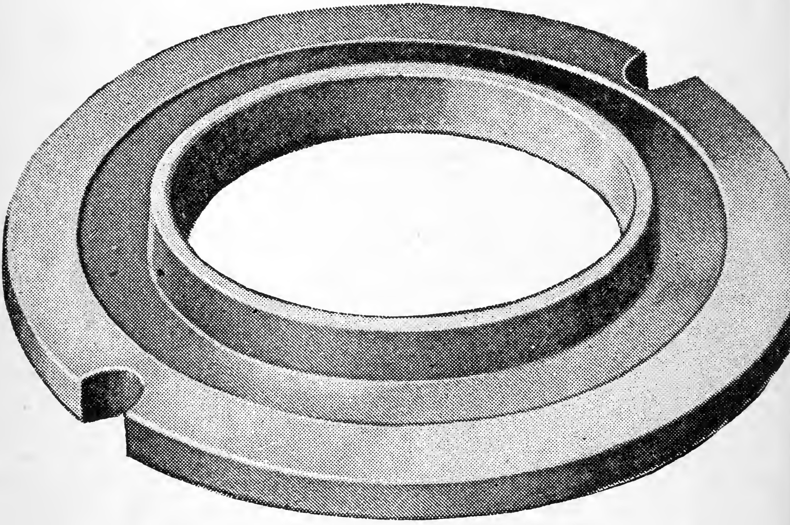
Plate 5002½-A shows closet with the sanitary-perfect screw connection and the threaded floor coupling which is connected to soil pipe.

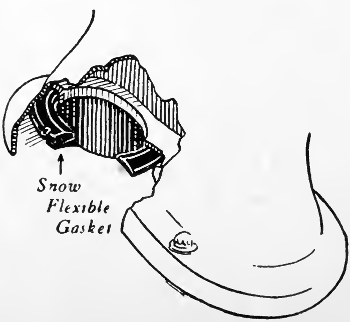
The section of the sanitary-perfect screw connection tion (Plate 5001-A) shows how the threaded brass screw connection is secured into the base of the closet. The joint thus formed makes the brass connection equivalent to an integral part of the closet which is impossible to loosen or disturb in the slightest degree, the taper thread insuring against leakage.

The Snow Flexible Gasket.

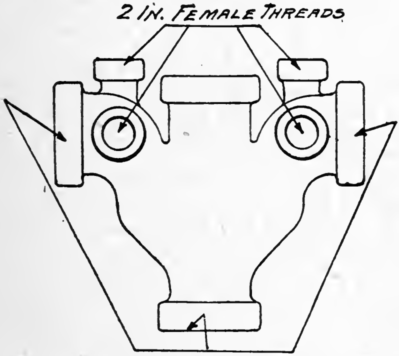
The Snow Flexible Gasket is the coming gasket for closet bowls. Putty is a thing of the past.

A good practical man will use a practical article instead of putty. The author of this book recommends The Snow Gasket as the best to be had. It makes an absolutely tight joint.





THIS FITTING WILL PREVENT TOILETS
FROM BACKING INTO EACH OTHER WHEN
BOTH ARE USED.

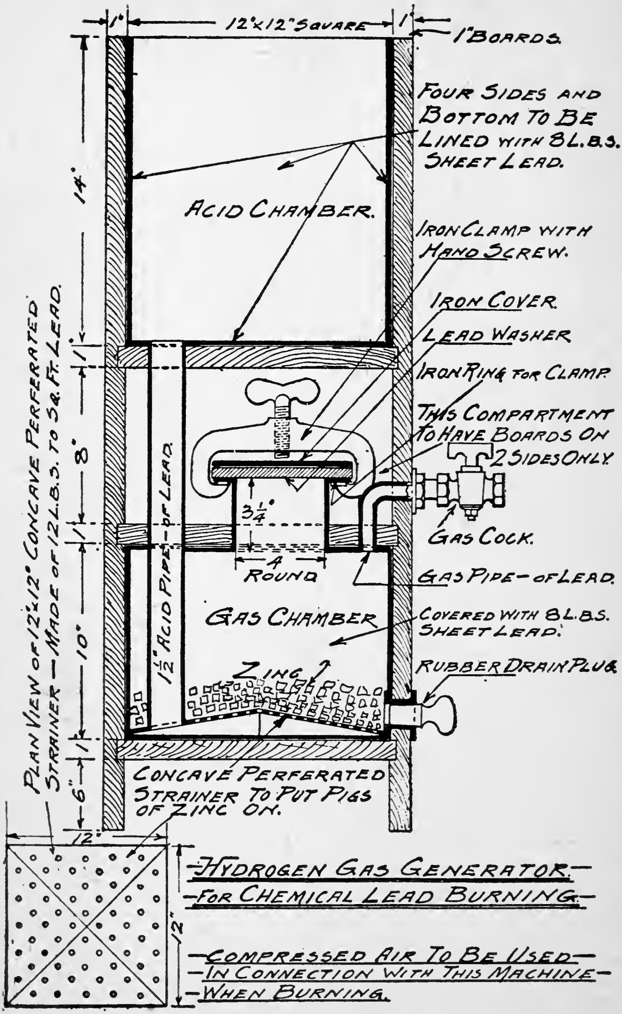


PROPER 4 IN. SOIL DRAINAGE FITTING.
FOR TOILETS WHEN BACK TO BACK.
TO BE USED FOR WALL OR FLOOR TOILETS

2 IN. TOP OPENINGS TO BE PLUGGED WHEN
FITTING IS USED LAYING FLAT.

2 IN. SIDE OPENINGS TO BE PLUGGED WHEN
FITTING IS USED UPRIGHT.

TO BE USED RIGHT OR LEFT.


1"
12"x12" Square
1"
1" Boards.
Four Sides and Bottom to be Lined with 8 L.B.S. Sheet Lead.
14"
Acid Chamber.
Iron Clamp with Hand Screw.
Iron Cover.
Lead Washer
Iron Ring for Clamp.
This Compartment to Have Boards on 2 Sides Only.
1"
8"
3 1/4"
1 1/2" Acid Pipe—of Lead.
4" Round
Gas Cock.
Gas Pipe—of Lead.
Gas Chamber
Covered with 8 L.B.S. Sheet Lead.
10"
Zinc
Rubber Drain Plug
1"
6"
Concave Perferated Strainer to Put Pigs of Zinc On.
Plan View of 12"x12" Concave Perferated Strainer—Made of 12 L.B.S. to Sq. Ft. Lead.
12"
12"
Hydrogen Gas Generator
For Chemical Lead Burning.
Compressed Air to be Used
In Connection with this Machine
When Burning.

PEPPERMINT TESTS.

When the work is complete, a peppermint test, satisfactory to the Supervisor of Plumbing, shall be made by the Plumber in the presence of a plumbing inspector. This test must be made within five days after the setting of fixtures.

Peppermint shall be pure oil, unadulterated in any manner, and used in the following proportions:

Fixtures.	Oil of Peppermint.
1 to 3 inclusive	2 ozs.
4 to 8 inclusive	3 ozs.
9 to 13 inclusive	4 ozs.
14 to 18 inclusive	5 ozs.
19 to 23 inclusive	6 ozs.
24 to 28 inclusive	7 ozs.
29 to 36 inclusive	8 ozs.
37 to 46 inclusive	9 ozs.
47 to 56 inclusive	10 ozs.
57 to 67 inclusive	11 ozs.
68 to 78 inclusive	12 ozs.
79 to 89 inclusive	13 ozs.
90 to 100 inclusive	14 ozs.
101 to 111 inclusive	15 ozs.
112 to 122 inclusive	16 ozs.
123 to 137 inclusive	17 ozs.
138 to 152 inclusive	18 ozs.
153 to 167 inclusive	19 ozs.
168 to 182 inclusive	20 ozs.
183 to 197 inclusive	21 ozs.
198 to 212 inclusive	22 ozs.
213 to 236 inclusive	23 ozs.
237 to 255 inclusive	24 ozs.
256 to 276 inclusive	25 ozs.
277 to 291 inclusive	26 ozs.
292 to 318 inclusive	27 ozs.
319 to 340 inclusive	28 ozs.
341 to 371 inclusive	29 ozs.
372 to 398 inclusive	30 ozs.
399 to 426 inclusive	31 ozs.
427 to 451 inclusive	32 ozs.
452 to 500 inclusive	33 ozs.

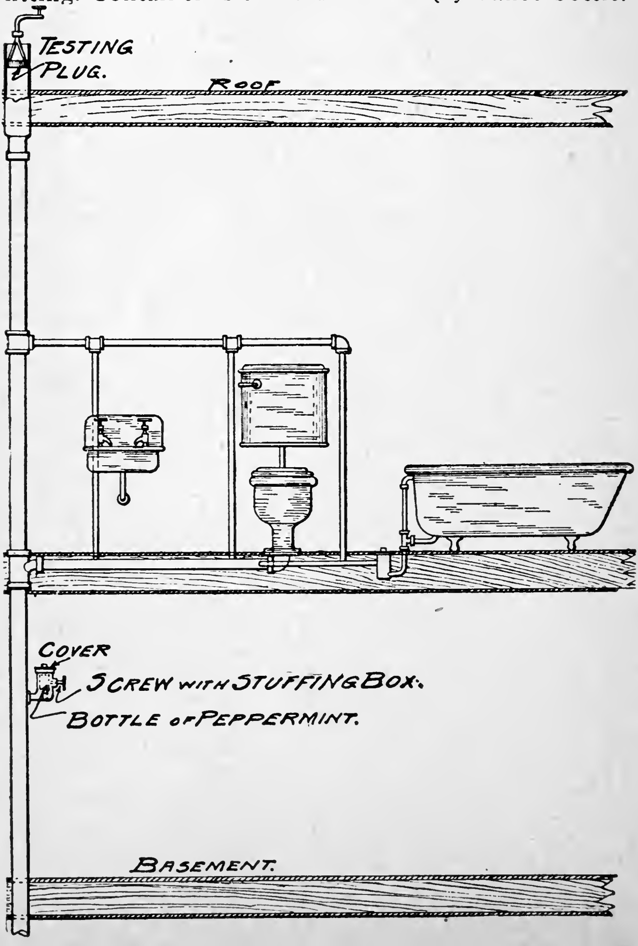
This test is the most severe test that the plumbing can get, as there is no way for the peppermint to get out unless there is some defect in joints, traps or connections. It is very simple as the test can be

left on for any length of time without the plumber's presence.

Operation is simple and as follows:

Insert and secure the test plug on the increaser at roof. After the pepermint retainer is screwed into the soil stack, close doors and windows. Place the peppermint bottle in the retainer and screw down the cover tight; then turn the screw, breaking the peppermint bottle. Let hot water run slowly in the bath tub.

Any plumber is enough of a mechanic to make one of these containers himself out of pipe and malleable fitting. Container is to hold a three (3) ounce bottle.



Combination of Steam Heating Boiler, Instantaneous Hot Water Heater and Hot Water Tank, for Domestic Use.

This System Designed by J. W. Johnson.

This system is equipped with a double boiler which has the same action as a thermos bottle. It can be connected to either hot water or steam boilers. Connection can be made below water line in steam boilers. In this heating design no coils are used over the fire in the boiler, as that is a thing of the past. On a tank of this kind from 100 to 150 square feet of radiation can be taken off in case of necessity. Radiation to be taken out from the outer boiler so as not to interfere with water for domestic use. I am showing a **Pittsburgh Instantaneous Heater,** which is considered one of the most rapid and best heaters on the market. The sketch merely shows a couple of radiators to make the lay-out more complete.

This system is laid out in such a way that in summer time, when the heating boiler is not used, the hot water is supplied by using the instantaneous gas hot water heater.

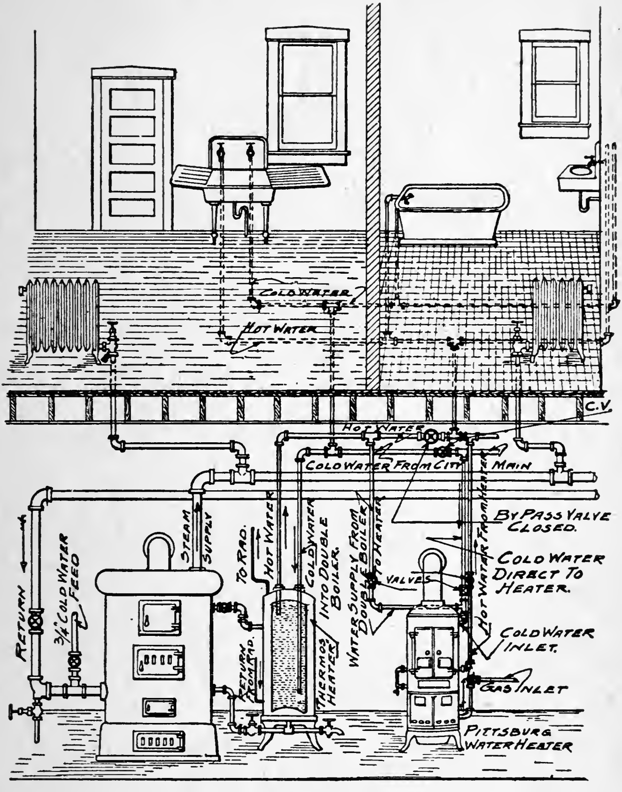
The cold water can be supplied to the heater in two ways, as follows: First, by **closing** valve marked "By-pass Valve" and **opening** the valve on the pipe marked "Cold Water Direct to Heater" and also **closing** the valve on line marked "Water Supply from Double Boiler." This way the heater will receive cold water direct from the city main and deliver hot water direct to the fixtures without passing through the "Double Boiler." The second way of using the heater in summer time is to let the cold water enter the "Double Boiler" and be tempered, thereby making quite a saving in the gas bill, as the tempered water will be from 20 degrees to 30 degrees warmer than the water would be if supplied directly to the gas heater from the city main. If this, the second method, is to be employed, all that has to be done is as follows: **Close** the valve on line marked "Cold Water Direct to Heater," when the city water will enter the Double Boiler and be tem-

pered. Then open the valve on line marked "Water Supply from Double Boiler to Heater" and close the valve marked "By-pass Valve" on sketch. Now, as the cold water under city pressure enters the Double Boiler through a pipe that extends within 6 inches of the bottom of the boiler, the water will be forced through pipe, marked "Hot Water," and run directly to the gas heater and circulate through the coil of the Instantaneous Heater and deliver hot water direct to the fixtures. The gas burner under the heater is controlled by a thermostat. When the water is of the desired temperature the thermostat shuts off the gas, so that merely the pilot light is burning; but the instant a hot water faucet is opened the gas is turned on full and burns until the faucet is closed again, when the gas shuts off and, as mentioned, only the pilot light is burning. In other words, the faucet controls the burner under the heater. By the way, hot water faucet shall always be placed on the left side.

During the cold season, when the heating boiler is in use, the gas heater is cut out of commission, which is done by closing the valve on the "Cold Water Direct to Heater" (which is placed on the vertical pipe and near the heater, just above the Tee) and the value on the horizontal cold water line (this valve is marked C. V. on sketch), when cold water supply to gas heater is shut off and instead it enters the Double Boiler.

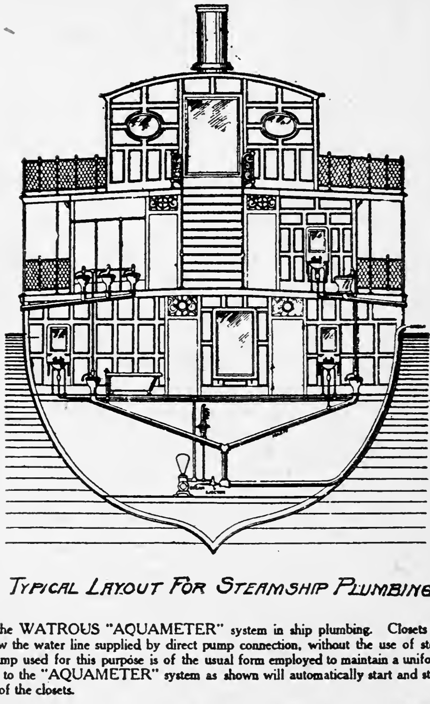
Valves on steam supply and return lines between Steam Heating Boiler and Double Boiler are opened, as is also the "By-pass Valve," when steam from the large boiler will enter the outside part of the Double Boiler and heat the water in the inside part. Cold water enters the latter now direct from the city main and is supplied to the hot water fixtures through the pipe marked "Hot Water."

Special attention should be given to following up the pipe lines and where valves are shown on the accompanying sketch.



HOT WATER TANK AND INSTANTANEOUS HEATER INSTALLATION

DESIGNED BY J. W. JOHNSON.



TYPICAL LAYOUT FOR STEAMSHIP PLUMBING.

Shows the WATROUS "AQUAMETER" system in ship plumbing. Closets are shown both above and below the water line supplied by direct pump connection, without the use of storage or sewage tanks. The pump used for this purpose is of the usual form employed to maintain a uniform pressure, and when connected to the "AQUAMETER" system as shown will automatically start and stop by the operation of any one of the closets.

Where closets are placed below the water line, the sewage therefrom is automatically discharged by means of a steam ejector, which is opened and closed by the increase and decrease of the water pressure in the supply pipes to which it is connected. The instant the pressure is reduced by the flushing of a closet, the ejector opens and allows the steam to escape into the 4-inch waste pipe, effectually discharging its contents and closing the instant the water stops flowing to the closets.

To provide against accident or possible failure of the ejector, a second starting means is located within the vent pipe and is arranged to operate independently of the first when the water has risen to a certain height in the waste pipe.

Method of Wiping Joints.

Watching somebody wipe joints, a clear description of how it is done, and acquaintance with the traits and qualities of materials used, are essential, but practice in the art of wiping joints has more to do with it making one proficient than has mere practice to do with proficiency in any other line of work. One may give the closest attention to the manual operation of making a thousand joints when the cloth and ladle are in the hands of some one else and yet fail to remember the how and wherefore for the hundred movements necessary to success.

Before commencing to wipe a joint, one should be positive that the pipe is firmly set, that the cleaning is well done and of proper length, that the junction of the ends is well made, so that solder will not run through into the pipe, that the edges are well pasted or otherwise protected, so that the solder will not adhere except at the cleaning, that no undue currents of air are passing through it, that there is enough solder in the pot to get up the heat and do the work and that the cloth is in good condition.

The beginner should keep the solder hot, leaving the pot in the furnace while practicing, so that he can put back and remelt the cold solder from time to time. He can do no better than to try to imitate the motions of those who know how. Practice will soon teach him a few points which words cannot explain to the inexperienced. Let the novice take the cloth in his left hand, holding it forward, so as to cover the tips of his fingers and take a ladle of solder in his right hand, hold the cloth under the cleaning and drop the solder, drop by drop, upon the different parts where the joint is to be made. A single drop of solder too hot will melt a hole through a pipe very quickly. Keep the ladle moving, so that the drops will fall in different places. When some solder gathers on the cloth put it up on top again and drop the solder on it and continue this operation until you have got the required amount of heat on the pipe so that your solder and the pipe is of the same heat and then form and wipe your joint.

Solder is a metal or alloy used to unite adjacent metallic edges or surfaces.

It must be rather more fusible than the metal or metals to be united, and with this object the compo-

nents and their relative amounts are varied to suit the character of the work.

As the melting point of lead is 617° to 626° according to the purity of the lead, solder must melt at a lower temperature.

The solder depends very much upon the nature and quality of both tin and lead.

No definite rule can be made for the melting points of plumbers' solder, although the following table is said to be nearly correct:

3 parts lead to 1	of tin, coarse melts at	.....480° F.
60 parts lead to 40	of tin, plumbers melts at	..440° F.
1 part lead to 1	of tin, fine melts at	.......370° F.
1 part lead to 1½	of tin, tin pipe melts at	....330° F.

It often happens that solder will become spoiled by getting zinc or other ingredients into it, which causes the solder to harden or crystallize contrary to its nature.

This is shown by the solder quickly setting or working badly, while if disturbed when cooling it is a kind of gray blue.

This is often caused by dipping brass or copper work into the pot for tinning, and also when soldering brass or copper to lead.

If too hot the zinc leaves the copper, and the tin takes it up, because the tin and zinc readily mix. A small portion of zinc will also cause the lead and tin to separate.

If there is zinc in solder, heat it to about 900° or nearly red hot, throw in a small quantity of sulphur (brimstone), which melts at 226° F. This high temperature is needed to melt the zinc, which melts at 773° F., and being lighter than lead or tin, has a tendency to float with the help of sulphur.

The sulphur mixes with the zinc and brings up all foreign substances to the surface.

Skim the solder well and after the heat is reduced to about the melting point of solder, add resin or tallow, to free the sulphur, and the solder should be clean.

Lead and tin can be separated by one rising above the other, so always stir before taking out a ladleful for use.

Never stir solder when red hot or burnt.

If allowed to burn, the nutriment or binding qualities are gone, and the pliable property which makes the solder work like butter, deducts from the ductility always needed in good working solder.

Some solder will work well for several heats and then become coarse; its appearance will be black and dull, become very porous and unreliable without more tin.

This is due to the fact that poor tin has been employed or some foreign substance, such as antimony, has been mixed with it. It will form teats or drops on the bottom of the joint and it will be difficult to make the joint. When this occurs, clean the solder with sulphur and resin and add tin to replace the deficiency caused by cleaning.

When solder hangs to the cloth it is too fine and needs a little lead, and when it sets too quickly or too coarse add tin.

Never leave sulphur in ladle or solder pot, as it cannot be cleaned without considerable trouble.

The fluxes generally employed for soldering, are, for iron, borax or sal-ammoniac; for zinc, brass or copper, sal-ammoniac or zinc chloride; for lead or tin pipe, resin or tallow.

A liquid for use in fine solder is made by dropping small pieces of zinc into two ounces of muriatic acid, until bubbles cease to rise, then dilute by adding water.

In tinning metals, the object is to prepare the surfaces that they may readily unite with the melted solder.

The tinning operation is best performed at a moderate heat. When overheated, the coating of solder, or the tinning as it is called, is reduced to a yellow powder and is destroyed. The tinning must be restored before it can be used.

Resin is recommended as a flux for tinning copper bits which are to be used for soldering lead and for tinning all brass and copper work upon which sof solder joints are to be wiped.

Articles composed of brass or copper, such as faucets, nipples, etc., should be tinned, filing to remove the coating or oxides, leaving the metal surface clean, then coating with a flux. Solder is then applied with a bit entirely covering the filed surface.

It is bad practice to dip brass articles into a pot of molten solder which is to be used for wiping purposes, because some of the zinc, of which the brass

is partly composed, will melt out and alloy with the solder, thus spoiling it. Articles composed wholly of copper, provided they are perfectly clean and free from filings, will do no injury to the solder.

Iron articles may be tinned by thoroughly cleaning the surfaces and treating them with sal-ammoniac before applying the solder.

Great care must be taken, when filing brass or other metals preparatory to tinning them, that the filings do not fall on the bench or such places that solder falling from wiped joints will pick them up. As a precaution, filing should not be done near the place where the wiping is to be done.

Solder flows better at high temperatures, provided the temperature is not so high as to oxidize it.

Solder will flow into a joint until it is chilled, therefore, it flows farthest when it possesses a large excess of heat above that which is necessary to maintain it in the fluid condition.

The heat necessary for making wiped joints is supplied wholly by the molten solder, thus, it is essential that the solder should possess a considerable surplus of heat. The temperature is limited, however, by the tendency of the solder to oxidize.

The strength of a joint not only depends upon the quantity, but the quality of the solder.

Too long manipulation spoils the solder and weakens the lead, the first joint made, if the metals are thoroughly fused, will be the most reliable, even if the shape is not perfect.

In making wiped joints, the metals to be joined should be heated to a temperature nearly equal to the fusing point of the solder.

Care should be taken that they are not heated beyond this temperature.

Fit ends of pipe tightly to prevent solder entering the interior, thoroughly clean all surfaces to be wiped, and immediately cover this cleaned surface with grease or oily matter, to prevent tarnishing.

In shaving, do not dig out the lead, as it is weakened and the joint cracks at the edges much sooner than it otherwise would.

It is of great importance that all wiped joints should be sound and reliable.

Patient practice until one can make a perfect joint is necessary. No wiped joint is perfect unless strong in body, perfectly fused, clean at the edges, true in form and free from solder inside.

In all joints the solder should be well mixed, and so fuse with the pipe that the metals will be perfectly united.

Wiped joints, properly made, are the strongest known to the trade, and generally recognized in the plumbing industry as one method of proving a plumber's status.

What is a metal?

An elementary mineral substance possessing considerable specific gravity, hardness and cohesion and requiring a high degree of heat to liquefy.

Give the symbol, ore and composition of the metals of interest to plumbers.

Lead
Tin
Zinc
Copper
Iron
Pb
Sn
Zn
Cu
Fe
Galena
Tinstone
Blende
Glance
Pyrites Iron
Magnetite
Hematite Iron and Oxygen
Lead and Sulphur
Tin and Oxygen
Zinc and Sulphur
Copper and Sulphur
Copper and Sulphur

Give the relative tenacity of the above metals.

Lead	1	or lowest.
Tin	1 1-3	times that of lead.
Zinc	2	times that of lead.
Copper	18	times that of lead.
Iron	27½	times that of lead.

Give the relative malleability of the five metals.

Copper, tin, lead, zinc and iron?

What does tenacity denote?

The relative power of resistance the metals have, to being torn apart.

On what does the malleability of a metal depend?

A great deal on its tenacity, coupled with softness.

What is the melting point of iron and some of its properties?

Melts at 2786° F., is very ductile and malleable and appears in three forms, malleable, or wrought, in its purest state, or cast, when containing carbon in different proportions.

At what temperature will zinc melt and what are its peculiarities?

Melts at 773° F., is somewhat brittle and fairly permanent in air. It is a protecting coating for iron under the name of galvanized iron, and dissolves easily in acids.

What are the peculiarities of tin and its melting point?

Melts at 428°, is a brilliant white metal in the pure state and produces a peculiar crackling noise when bent, called the "cry" of tin. It is very malleable, but also slightly ductile.

What is copper, its melting point and some of its uses?

An elementary metallic substance of a pale, red color, moderately hard, malleable and ductile. Copper fuses at 1742° F. It is the most useful of all the metals for alloy. Mixed with tin it forms bronze; with zinc it forms brass; is a good conductor of heat and electricity and one of the most useful of metals.

What is brass, its uses and melting point?

It is composed of copper and zinc of different proportions and has no certain temperature for fusing, as the component parts vary; about 1100° F. It is

one of the most useful of alloys, more fusible than copper and not so apt to tarnish. It is malleable when cold, but not so when heated.

Describe the properties of lead, its melting point and some of its uses?

Lead is of a bluish gray color, very soft and of slight tenacity. Its proper name is galena or sulphide of lead. It melts at 612° to 617° F., according to its purity. It is used in the arts and sciences, and combines with other metals in various alloys.

What are alloys and some of their properties?

An alloy is a combination by fusion of two or more metals. All alloys are opaque, have a metallic luster, are more or less ductile, elastic and malleable, also good conductors of heat and electricity.

What is solder, and of what is plumbers' solder composed?

A metal or alloy to unite adjacent metallic edges or surfaces and is composed of lead and tin in different proportions.

What are the proportions of lead and tin in plumbers' solders, and their melting points?

Coarse mixture	3 lead	1 tin,	melts 480°
Plumbers' mixture	60 lead	40 tin,	melts 440°
Fine mixture	1 lead	1 tin,	melts 370°
Tin pipe mixture..........	1 lead	1½ tin,	melts 330°

What spoils solder and how should it be cleaned?

Allowing zinc or antimony to mix with it and by burning it.

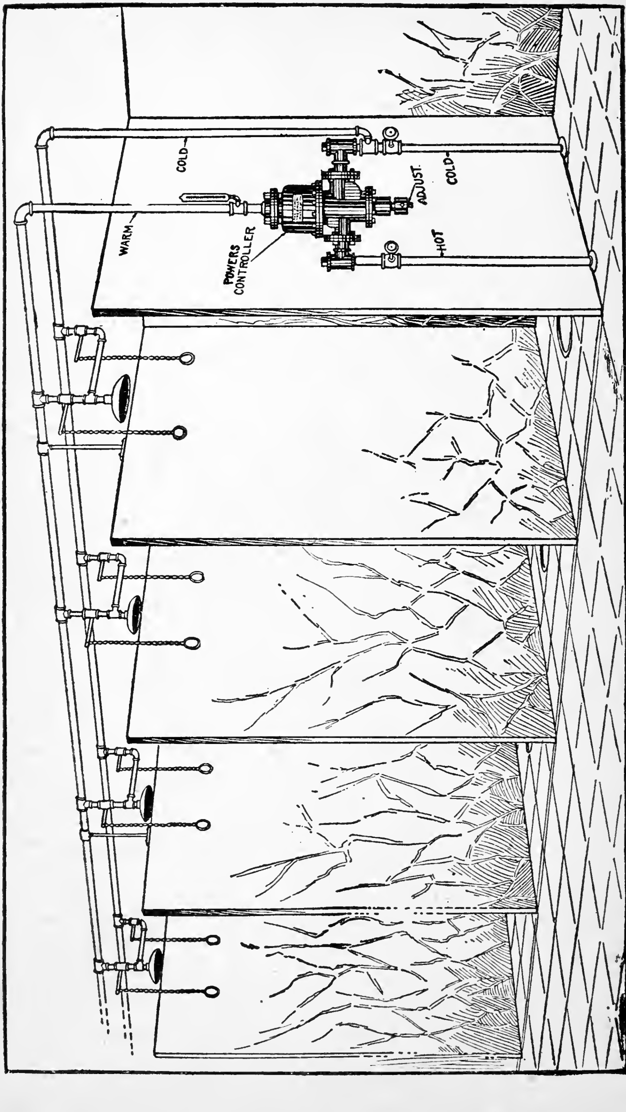
Clean it by heating the solder to 900° or more, introducing sulphur, which helps impurities to rise. When this is skimmed, put in resin, and the mixture should be purified. This high temperature is needed to melt antimony which fuses at 834°, and zinc at 773°.

Why should solder never be allowed to burn?

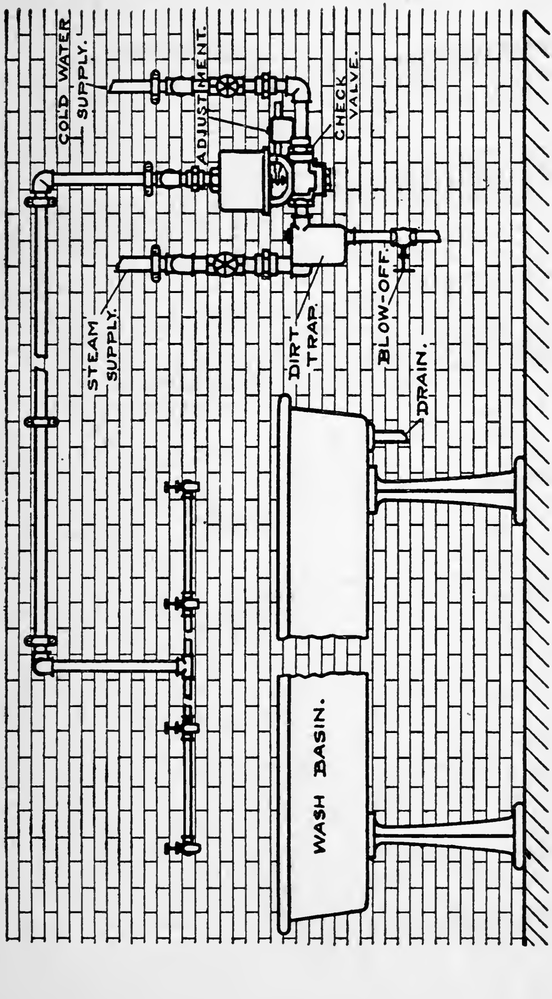
Because the pliable property and nutriment are extracted.

What are some of the fluxes used in soldering different metals?

For iron, borax or sal-ammoniac. For zinc, copper or brass,—sal-ammoniac or zinc chloride. For lead or tin pipes,—tallow or resin. Also, for iron and zinc, drop small pieces of zinc into two ounces of muriatic acid until bubbles cease to rise; then add a little water.



Powers Thermostatic Control used on Gang Shower for factory use.



Illustrating Powers Economical Mixer used for factory work.

"PERFECTION" SEWAGE SYSTEM.

Disposes of Waste Scientifically.

You can eliminate the dangerous, unsightly outdoor closet, the filthy disease breeding cesspool, and make the home as modern, sanitary and convenient as any city residence.

You can enjoy, every day, in the home, the convenience of modern plumbing—the best appointed bath room, a handy sanitary kitchen sink, and convenient plumbing connections with the laundry.

These modern conveniences are made possible by the "Perfection" Sewage System, which will give every country home equipped with a water system a PRIVATE sewage disposal plant—a system that will not merely carry sewage away, as does the city sewage system, but will transform bath room wastes and kitchen slop into clear water, free from filth, disease germs, and offensive odors.

Hundreds of country people are already enjoying the conveniences of this system. The health of thousands of people is being protected through the elimination of typhoid, scarlet fever, and diphtheria dangers, which come from outside closets and open cesspools. Many owners of country homes have installed water systems in order to enjoy the protection and convenience of a sewage disposal plant.

Of all systems there is none equal to the "Perfection" sewage system. It can be built by any plumber, with the assistance of a competent concrete builder, but, as it is patented (and the manufacturers' charge is very low), I advise plumbers to get in communication with the manufacturers and get their prices. Plumber will find that he cannot get one made—and made of reinforced concrete—as cheap as he can buy one from the manufacturers and get their guarantee besides. They build hundreds of them every year and ship them "knocked down"; all the plumber has to do is to assemble it, according to makers' instructions. It is manufactured by the "United Cement Products Company," Indianapolis, Ind., and can, most likely, be gotten through your jobber.

This is the very latest and best system for disposing of sewage waste. The illustration gives the idea of the construction of the septic tank. It is

made of reinforced concrete in three or more compartments, according to capacity required, and is air and water tight. The residence size, for eight people, and less, is 7′–4″ long, 32″ wide and 27″ deep inside. Larger sizes are in proportion to increased number of persons. It is also suitable for factories, churches, schools, and public buildings.

How It Transforms Sewage.

All sewage contains bacteria, insects so small that they can be seen only by means of a powerful microscope, which are the kind that thrive in dark, air tight places. In the "Perfection" septic tank they multiply to millions and literally eat and digest all the wastes entering it, reducing them to their constituent parts, which in all pure sewage are 998 parts water in every thousand. Nothing but water leaves the tank. After it leaves the tank it passes through a bed of gravel or broken stone where it is aerated and all offensive odors are eliminated. It then passes out through the earth or empties into a dry well, tile drain or stream.

Nothing is visible; the tank and filter bed are built deep in the ground. There are no spots to yield odors or to breed flies and disease germs. The "Perfection" sewage system works silently and efficiently, giving great convenience and promoting health.

Once installed this system needs no further attention. Fifty years may elapse and it will still be performing its work in the same efficient way. Being made of reinforced concrete, the tank itself is indestructible, and the bacterial action on the waste entering the tank, which reduces it to water, will be the same in the tenth, twentieth or fiftieth year as in the beginning.

An examination of a tank after five years' service revealed only about one-quarter of an inch of soft substance, showing that it never need be cleaned out.

CONNECTIONS FOR COLD WATER SUPPLY.

In most instances water is supplied to residences, apartments, and also factories from the "city main." Plumbers merely extend a line or two, according to the size of building, and connect to the main. As far

as sizes of these extensions are concerned it has been arbitrary, most plumbers using a ¾" supply for small buildings and 1" to 2" for larger ones, basing the size of the supply on the number of fixtures to be supplied. They have disregarded the length of the run and the pressure. In many instances the consequence has been that at certain times, when several fixtures were being used at the same time, hardly any flow of water could be obtained out of the fixtures. This is due to the fact that a large majority of plumbers, being practical but not theoretical men, do not know of any rule to determine accurately the amount of water that can be delivered through a certain size of pipe when the length of the run of pipe and the water pressure is known. With long run and low pressure a larger supply pipe will naturally be required. That the plumber knows, but how much larger?—That's the stumbling block. There are several formulas or rules for ascertaining this, but they are so complicated that a man with a common education cannot understand them. The two tables given here are so plain that any plumber can use them and determine if 1" pipe or 24" pipe is required. The author also gives a few examples showing how the tables are used.

The laws of gravity are the basis for the science of hydraulics, of which the main factor of every problem is VELOCITY. All bodies falling freely descend at the same rate,—in round numbers, 16 feet for the first second and at the end of which the velocity has increased to 32 feet per second. This is the basis on which are formulated the laws of falling bodies, which, exhibiting what is known as VELOCITY OF EFFLUX, together with loss by friction, must be considered when calculating the flow of water. There are three kinds of velocity; UNIFORM, ACCELERATED and RETARDED. It is the last and its cause, friction, that plumbers should be most interested in, as velocities calculated merely from laws of falling bodies do not take account of friction, change of course, etc., which must be allowed for as causes diminishing the delivery of water through pipes.

An accepted formula for calculating the velocity is as follows: $\sqrt{2\ g\ h} = V$, which means that ve-

locity is found by extracting the square root of the product of the head multiplied by 2×32,—g standing for the force of gravity and h for the height. For example, a stream filling a 1″ pipe, with 25 feet head of water, would have a velocity calculated thus: $2 \times 32 \times 25 = 1,600$; and the square root of $1,600 = 40 =$ velocity, friction not considered.

The orifice, or hole, through which water enters a pipe, has much to do with the amount of water that will enter. Friction against the sides of the pipe and change in direction, due to bends, etc., are causes for great variation from the theoretical flow. Not only is the condition of the inside of the pipe and fittings to be considered as causes varying the delivery, but velocity, the very important factor, must also be taken in consideration in every case. With a velocity of 10 feet per second in a pipe of comparatively smooth interior surface, the friction loss in pounds on one square foot of surface will be about ½ pound. If the velocity is increased or diminished, the factor of friction will vary accordingly, always in proportion to the square of the velocity. Suppose the velocity to be 20 feet instead of 10 feet per second; we than have, 10 squared equals 100, and 20 squared equals 400. The square of these velocities is as 1 to 4, and as we assign a ½ pound loss to 10 feet of velocity per second, on a stated amount of surface, the friction due to doubling the velocity should be four times a ½ pound, which equals 2 pounds, showing that doubling velocity increases the friction four-fold; trebling it increases friction nine-fold, etc.

A column of water weighs .43 pounds per square inch of base, per vertical foot. Therefore, a vertical pipe 100 feet high, with one-inch sectional area, filled with water, will contain 43 pounds, and a gauge placed at base of pipe would indicate 43 pounds pressure. If the pipe was ¼ inch, or was 30 inches in diameter, the gauge would show the same pressure for the same vertical height, namely, .43 pounds per square inch per vertical foot. A head of water expressed in feet, may be changed to pounds by multiplying the feet of head by .43. Pressure is made to read in feet of head by multiplying pressure per square inch by 2.3. A HEAD OF WATER is the number of vertical feet from level of source of supply to center of outlet point of delivery.

Diameter of the pipe has nothing to do with the static head or pressure; but its relation to the size of the orifice from which the water is to be drawn has much to do with the amount of pressure lost by friction. If a faucet and supply pipe are of the same size and we DOUBLE the size of the pipe, the velocity of the water flowing through it is reduced three-fourths; and friction is, under these conditions, but one-sixteenth what it was in the original size. Furthermore, as in drawing similar amounts of water under the same head through a one-inch and two-inch pipe, the amount of friction surface presented is twice as great in the one-inch as in the two-inch pipe. The friction in the one-inch can be shown to be 32 times as much as in the two-inch pipe.

By using the formula it is possible to find the approximate theoretical delivery. A liberal percentage must be deducted for friction, based on size, length of pipe and head or pressure.

The two tables, with the rules of how to use them, will be of great value for ready reckoning.

Table No. 1 shows the pressure of water in pounds per square inch for elevations varying in height from 1 foot to 135 feet.

Table No. 2 gives the drop in pressure due to friction in pipes of different diameters for varying rates of flow. The figures given are for pipes 100 feet in height. Frictional resistance in smooth pipes having a constant flow of water through them is proportional to the length of pipe. That is, if the friction causes a drop in pressure of 4.07 pounds per square inch in a 1¼ inch pipe, 100 feet long, which is discharging 20 gallons per minute, it will cause a drop of 4.07×2 equals 8.14 pounds in a pipe 200 feet long; or $4.07 \div 2$ equals 2.03 pounds in a 50 feet long pipe. The factors in the table are for pipes of smooth interior, as wrought iron, brass, or lead.

Examples. A 1½ inch pipe, 100 feet long, connected with a tank, is to discharge 35 gallons per minute. At what elevation above the end of the pipe must the surface of the water in the tank be to produce this flow?

TABLE I.

Head in Feet.	Pressure Pounds per Square Inch	Head in Feet	Pressure Pounds per Square Inch	Head in Feet.	Pressure Pounds per Square Inch
1	.43	46	19.92	91	39.42
2	.86	47	20.35	92	39.85
3	1.30	48	20.79	93	40.28
4	1.73	49	21.22	94	40.72
5	2.16	50	21.65	95	41.15
6	2.59	51	22.09	96	41.58
7	3.03	52	22.52	97	42.01
8	3.46	53	22.95	98	42.45
9	3.89	54	23.39	99	42.88
10	4.33	55	23.82	100	43.31
11	4.76	56	24.26	101	43.75
12	5.20	57	24.69	102	44.18
13	5.63	58	25.12	103	44.61
14	6.06	59	25.55	104	45.05
15	6.49	60	25.99	105	45.48
16	6.92	61	26.42	106	45.91
17	7.36	62	26.85	107	46.34
18	7.79	63	27.29	108	46.78
19	8.22	64	27.72	109	47.21
20	8.66	65	28.15	110	47.64
21	9.09	66	28.58	111	48.08
22	9.53	67	29.02	112	48.51
23	9.96	68	29.45	113	48.94
24	10.39	69	29.88	114	49.38
25	10.82	70	30.32	115	49.81
26	11.26	71	30.75	116	50.24
27	11.69	72	31.18	117	50.68
28	12.12	73	31.62	118	51.11
29	12.55	74	32.05	119	51.54
30	12.99	75	32.48	120	51.98
31	13.42	76	32.92	121	52.41
32	13.86	77	33.35	122	52.84
33	14.29	78	33.78	123	53.28
34	14.72	79	34.21	124	53.71
35	15.15	80	34.65	125	54.15
36	15.59	81	35.08	126	54.58
37	16.02	82	35.52	127	55.01
38	16.45	83	35.95	128	55.44
39	16.89	84	36.39	129	55.88
40	17.32	85	36.82	130	56.31
41	17.75	86	37.25	131	56.74
42	18.19	87	37.68	132	57.18
43	18.62	88	38.12	133	57.61
44	19.05	89	38.55	134	58.04
45	19.49	90	38.98	135	58.48

TABLE 2

Gallons Discharged Per Minute		5	10	15	20	25	30	35	40	45	50	75	100	125	150	175	200
½ In.	Velocity in Feet Per Second	8.17	16.3	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	Friction Loss in Pounds	24.6	96.0	...	...	...	...	...	...	...	...	...	...	...	...	...	...
¾ In.	Velocity in Feet Per Second	3.63	7.25	10.9	14.5	18.1	...	...	...	...	...	...	...	...	...	...	...
	Friction Loss in Pounds	3.3	13.0	28.7	50.4	78.0	...	...	...	...	...	...	...	...	...	...	...
1 In.	Velocity in Feet Per Second	2.04	4.08	6.13	8.17	10.2	12.3	14.3	16.3	...	...	...	...	...	...	...	...
	Friction Loss in Pounds	.84	3.16	6.98	12.3	19.0	27.5	37.0	48.0	...	...	...	...	...	...	...	...
1¼ In.	Velocity in Feet Per Second	1.31	2.61	3.92	5.22	6.53	7.84	9.14	10.4	11.7	13.1	19.6	...	...	...	...	...
	Friction Loss in Pounds	.31	1.05	2.38	4.07	6.40	9.15	12.04	16.10	20.2	24.9	56.1	...	...	...	...	...
1½ In.	Velocity in Feet Per Second	.91	1.82	2.73	3.63	4.54	5.45	6.36	7.26	8.17	9.08	13.6	18.2	...	...	...	...
	Friction Loss in Pounds	.12	.47	.97	1.66	2.62	3.75	5.05	6.52	8.15	10.0	22.4	39.0	...	...	...	...
2 In.	Velocity in Feet Per Second	...	1.02	1.53	2.04	2.55	3.06	3.57	4.09	4.60	5.11	7.66	10.2	12.3	15.3	17.1	20.4
	Friction Loss in Pounds	...	.12	.27	.42	.67	.91	1.25	1.60	2.02	2.44	5.32	9.46	14.9	21.2	28.1	37.5
2½ In.	Velocity in Feet Per Second	...	...	...	...	1.63	...	...	...	...	3.26	4.90	6.53	8.16	9.80	11.4	13.1
	Friction Loss in Pounds	...	...	...	...	.21	...	...	...	...	.81	1.80	3.20	4.89	7.00	9.46	12.47
3 In.	Velocity in Feet Per Second	...	...	...	...	1.13	...	...	...	...	2.27	3.40	4.54	5.67	6.81	7.94	9.08
	Friction Loss in Pounds	...	...	...	...	.10	...	...	...	...	.35	.74	1.31	1.99	2.85	3.85	5.02

——In table No. 2 we find the friction loss for 1½ inch pipe discharging 35 gallons per minute to be 5.05 pounds. In table No. 1 we find a pressure of 5.2 pounds corresponds to a head of 12 feet, which is approximately the elevation required.

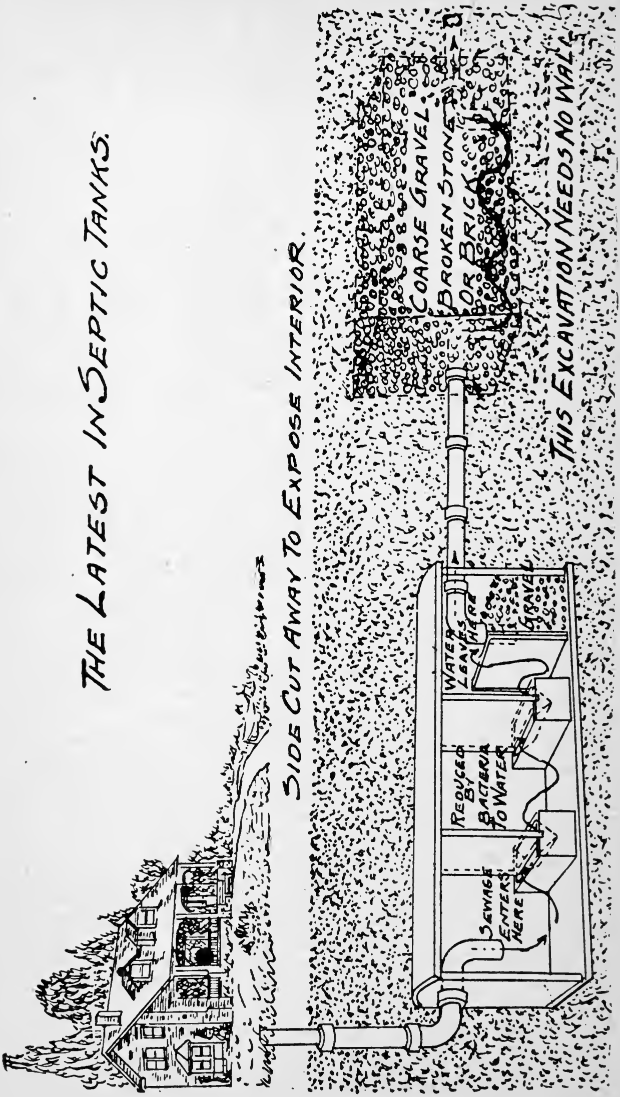
——How many gallons will be discharged through a 2 inch pipe, 100 feet long, when the inlet is 22 feet above the outlet? In table No. 1 we find a head of 22 feet corresponds to a pressure of 9.53 pounds. Then, looking in table No. 2, we find in the column of Friction Loss for a 2 inch pipe that a pressure of 9.46 corresponds to a discharge of 100 gallons per minute.

Tables No. 1 and No. 2 are commonly used together in examples.

——A house requiring a maximum of 10 gallons of water per minute is to be supplied from a spring which is located 600 feet distant, and at an elevation of 50 feet above point of discharge. What size of pipe will be required? From table No. 1 we find an elevation or head of 50 feet will product a pressure of 21.65 pounds per square inch. Then, if the length of the pipe was only 100 feet, we should have a pressure of 21.65 pounds available to overcome the friction in the pipe, and could follow along the line corresponding to 10 gallons in table No. 2 until we come to friction loss corresponding closest to 21.65, and take the size of pipe corresponding. But as the length of pipe is 600 feet, the friction loss will be six times that given in table No. 2 for given sizes of pipe and rates of flow; therefore, we must divide 21.65 by 6, to obtain the available head to overcome friction, and look for this quantity in table, $21.65 \div 6 = 3.61$, and table No. 2 shows that a one inch pipe will discharge 10 gallons per minute with a friction loss of 3.16 pounds, and this is the size that should be used.

Example for Practice.

1. What size pipe will be required to discharge 40 gallons per minute, a distance of 50 feet, with a pressure head of 19 feet? Answer: 1¼ inches.
2. What head will be required to discharge 100 gallons per minute, through a 2½ inch pipe, 700 feet long? Answer: 52 feet.


THE LATEST IN SEPTIC TANKS.
SIDE CUT AWAY TO EXPOSE INTERIOR.
COARSE GRAVEL
BROKEN STONE OR BRICK
THIS EXCAVATION NEEDS NO WALL
WATER LEAVES HERE
GRAVEL
REDUCED BY BACTERIA TO WATER
SEWAGE ENTERS HERE

SOIL, WASTE AND VENT PIPES.

On the following pages are given charts and sketches for the guidance of the plumber.

The sketches and reading matter in this treatise on soil, waste and vent pipes were compiled, to a certain extent, from the State Plumbing Code of one of the states that, in my estimation, has one of the best and most complete plumbing codes.

Chart A shows kinds of fixtures, number of fixtures, sizes of traps, diameter of soil, waste and vent pipes.

Note. In determining the size of the soil and waste pipe given in Chart A, allow in addition to each closet permitted, one bath, one basin, and one sink or other similar fixture. In determining the size of vent pipe, allow, in addition to each closet permitted, one bath, one basin and one sink or other similar fixture.

Materials. All main and branch soil, waste, vent, and back vent pipes shall be made of cast iron coated with tar or asphaltum, galvanized wrought iron or steel pipe, or lead, brass, or cooper.

Minimum Size of Vent Stack. Where not more than two water closets are installed below the first floor and serve as the only closets in the building, the vent pipe shall not be less than two inches. In determining the size of the vent pipe, allow in addition to the closet, one bath, one basin, and one sink or other similar fixture. The size of the vent and waste pipes for basins, sinks, baths, or other similar fixtures when they serve as the only fixtures in a building shall be governed by the provisions of Chart A.

Four Inch Stack May Be Decreased. A closet may be installed on a four inch soil pipe rising from house drain to first and second floors, and may be vented with a two inch vent pipe, provided the premises where such closet is to be installed has a four inch soil pipe stack of undiminished size extending through the roof.

In garages, barns, etc., a closet may be installed on the first or ground floor and may be vented with a two inch pipe.

Roof Extensions. All soil and waste pipes receiving the discharge of any fixtures shall be extended the full calibre above the roof, except as mentioned under heading "FOUR INCH STACK MAY BE

12

CHART SHOWING KINDS OF FIXTURES.—NUMBER OF FIXTURES,—SIZES OF TAPS,—DIAM. OF SOIL,—WASTE, AND VENT PIPES.

KIND OF FIXTURES.	SOIL AND WASTE		VENT.		SIZES OF TRAPS REQUIRED	MAXIMUM DEVELOPED LENGHT OF VENT PIPE PERMITTED.
	NO. OF FIXTURES ALLOWED	SIZES OF SOIL AND WASTE.	NO. OF FIXTURES ALLOWED	SIZES OF BACK VENTS		
CLOSETS.	5	3"	6	2"	2½ TO 4	60
	6	4"	7–10	2½"		80
	7–15	5"	11–20	3"		100
	16–36	6"	21–40	3½"		120
	37–64	8"	41–75	4"		150
	65–100	10"	76–100	6"		250
SLOP SINK WITH TRAP COMBINED	2	2"	1	1½"	2" TO 4"	40
	6	3"	6	2"		60
	7–15	4"	7–10	2½"		80
	16–36	5"	11–20	3"		100
	37–64	6"	21–	3½"		120
SINKS, BATH TUBS LAUNDRY TRAYS, ORDINARY SLOP SINKS— SMALL SINGLE URINALS & SHOWER BATHS	1	1½"	4	1½"	1½" OR 2"	40
	1–4	2"	5–8	2"		60
	5–6	2½"	9–17	2½"		80
	7–10	3"	13–20	3"		100
	11–15	3½"	21–30	3½"		120
	16–30	4"	31–	4"		150
WASH BASINS, CUSPIDORS BUBBLERS, REFRIGERATORS	1	1¼"	2	1¼"	1¼" OR LARGER	25
	1–4	1½"	2–6	1½"		40
	4–10	2"	6–15	2"		60
	10–25	3"	15–40	3"		100
	25	4"	40–	4"		150
FLOOR DRAINS	1	2"	6	2"	2" TO 6"	60
	1–4	3"	6–10	3"		100
	4–8	4"	10	4"		150
	8–36	6"	....	....		
BAR CONN.	....	1½" TO 3"	....	1½" TO 2"	1½" OR LARGER	40 TO 60
LONG TROUGH PEDESTAL, COMBINED TRAP & PORCELAIN STALL URINALS.	1	2"	2	1½"	2" TO 4"	40
	1–4	3"	1–4	2"		60
	4–10	4"	4–12	2½"		80
	10–25	5"	12–30	3"		100
	25–	6"	30	4"		150.

CHART A.

DECREASED," and as shown on sketch No. 5. In no case shall a vent pipe through the roof be less than four inches in diameter. The roof terminals of such vent pipes must extend at least three feet above any door, window, scuttle or air shaft or any other openings used for ventilation when located at a distance less than twelve feet from such terminals. See sketches No. 25 and No. 27. Change in diameters shall be made by long increasers at least one foot below roof.

Protection from Frost. All drain, soil, waste, or vent, and supply pipes shall be as direct as possible, properly protected from frost, and when possible arranged so as to be readily accessible for inspection and repairs.

Branch Soil and Waste Extensions. Any vertical or any horizontal branch running vertically, horizontally, or both, more than thirty feet from the soil line, shall be continued full size to a point above the roof in the same manner as required for main soil pipes or may be returned to main vent pipe full size. (See sketch No. 9.)

Traps, Distance from Vents. The back vent of any fixture trap shall be as close to the trap as practicable, consistent with its location and effectiveness.

One or Two Water Closets or Similar Fixtures. Two water closets located on the same floor discharging into a double Y or sanitary Tee cross, or any closet discharging into a Y branch or sanitary Tee, need not be back vented, provided that the developed distance of the horizontal soil branch extended with a grade of not less than ¼ inch per foot does not exceed the inside diameter of the soil branch and the vertical leg between the horizontal soil branch and the trap water level does not exceed two feet.

Fixtures Other Than Water Closets. Two fixtures other than water closets discharging into a double Y or sanitary Tee cross or an individual fixture other than a water closet discharging into a Y branch or sanitary Tee need not be back vented, providing the total fall of the waste pipe between water level of the trap and the vent pipe extended at a grade of not less than ¼ inch per foot does not exceed the inside diameter of the branch waste pipe. (See sketch No. 7.)

Crown Vent Prohibited. In no case shall the vent be taken off from the crown of the trap. (See sketches No. 10 and No. 11.)

Vents Reconnected. All vents shall be run separately through the roof; or be reconnected at least eight inches below the roof; or be reconnected to the main vent pipe not less than three feet above the highest floor on which fixtures are placed. No fitting for future waste connections shall be placed in any soil or waste pipe above the point of revent connection. (See sketch No. 27.)

Vent Pipe Grades and Connections. All branch vent and back vent pipes shall be free from drops or sags, and shall be so graded and connected as to drip back to the soil or waste pipe by gravity. Whenever it becomes necessary to trap a horizontal vent pipe, the proper method for doing so must be complied with. (See sketch No. 12.)

Fixtures Parted by Walls. Where bath rooms, water closets, or other fixtures are located on opposite sides of a wall or partition, or are directly adjacent to each other in two inseparable buildings, such fixtures may have a common soil or waste pipe and vent pipe stack.

Continuous or Circuit Vent Installation. Batteries of closets, urinals, sinks, basins, etc., may be installed by a continuous or circuit vent system. Loops and circuit vents shall be of following sizes: 2 inches for a battery of two closets, 3 inches for a battery of five closets, 4 inches for a battery of six to twelve closets. For urinals, sinks, basins, or similar fixtures the loop or circuit shall be of size provided in Chart A. Methods of such installation are shown in sketches Nos. 13, 14, and 15.

Unit Vent. Two water closets located on the floor discharging into a double Y or sanitary Tee cross in a soil or waste stack, need not be back vented, provided that the developed distance of the horizontal soil pipe branch extended with a grade of ¼ inch per foot does not exceed the inside diameter of the soil pipe, and the vertical leg between the horizontal soil pipe branch and the trap water level does not exceed two feet. Two fixtures other than water closets discharging into a double Y or sanitary Tee cross, with no fixtures discharging above them, may be back vented through a common vent or back vent pipe, provided the total fall between the water

level of the trap and vent pipe does not exceed the inside diameter of the waste pipe extended at a grade of ¼ inch per foot. (See sketches Nos. 15 and 16.)

Back Vents Not Required. Basement or cellar floor drains, subsoil traps, elevator catch basins, and similar fixtures need not be back vented when branched into a horizontal house drain five feet or more from the base of a soil pipe stack.

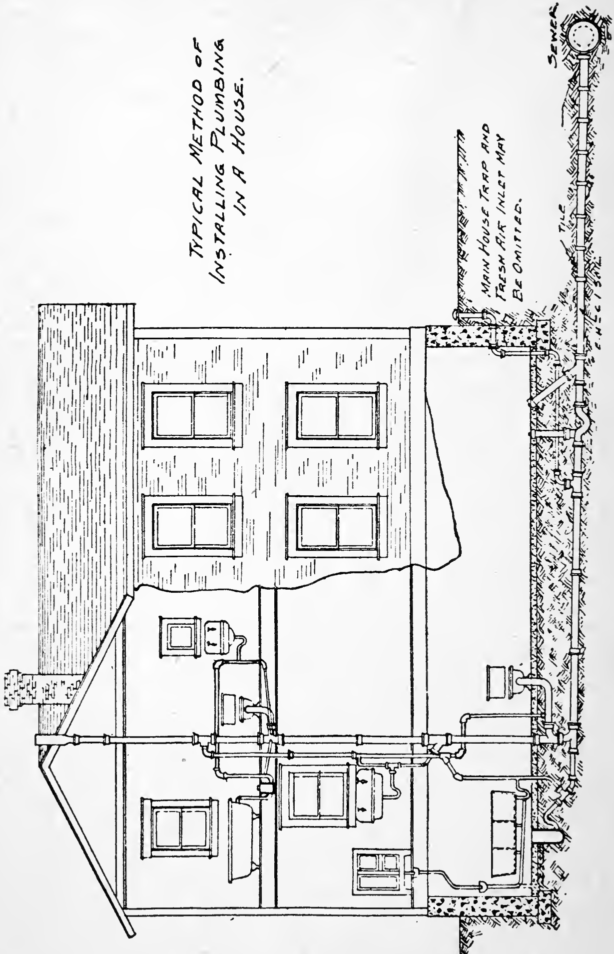
Grade of Horizontal Pipes. All horizontal drain, soil and waste pipes shall be run in a practical alignment and at the uniform grade of ¼ inch per foot, or more; but in no cases shall the grade be less than ⅛ inch per foot, whether under the cellar floor or supported by piers, posts wall ledges, or iron hangers.

To Increase or Reduce Size of Pipes. Proper fittings of sanitary design shall be used to increase or reduce the size of pipes.

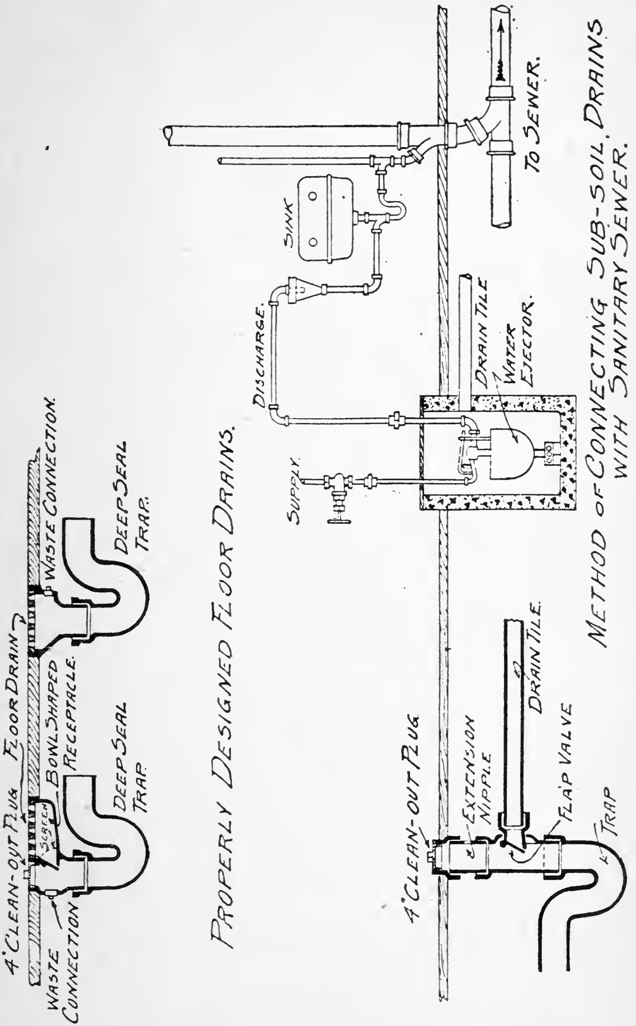
Hangers and Supports. All hangers, pipe supports, and fixture settings in or against masonry, concrete or stone backing shall be securely made with expansion bolts or other approved methods, without the use of wood plugs. All drainage and plumbing pipes shall be rigidly secured and supported so that the proper alignment will be retained.

Backgrounds. Backgrounds, except under special conditions, must be provided for securing of closets, tanks, basins, sinks, brackets, and all other wall fixtures or hangings.

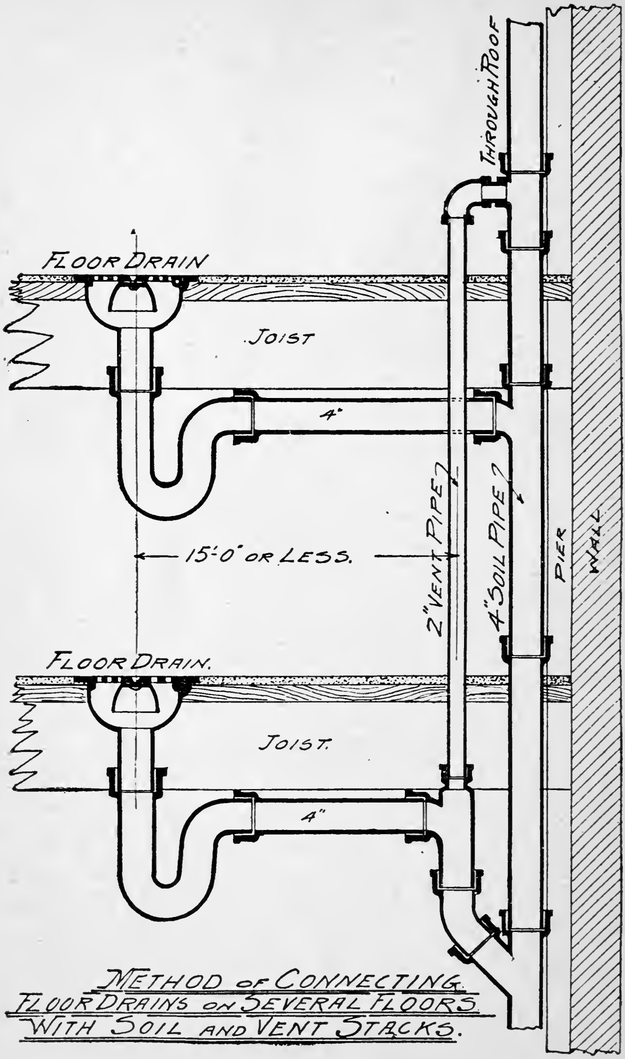
Stack Supports. All stacks shall be thoroughly supported on concrete, masonry piers or foot rests at their bases; all those ten feet or more in height shall also be provided with floor rests or other substantial supports at ten feet or floor intervals. All pipe supports shall be made of heavy iron posts, wall hangers or brackets, steel fittings or concrete or masonry piers. All brick piers shall be at least 8 inches square.


TYPICAL METHOD OF
INSTALLING PLUMBING
IN A HOUSE.
MAIN HOUSE TRAP AND
FRESH AIR INLET MAY
BE OMITTED.
TILE
SEWER

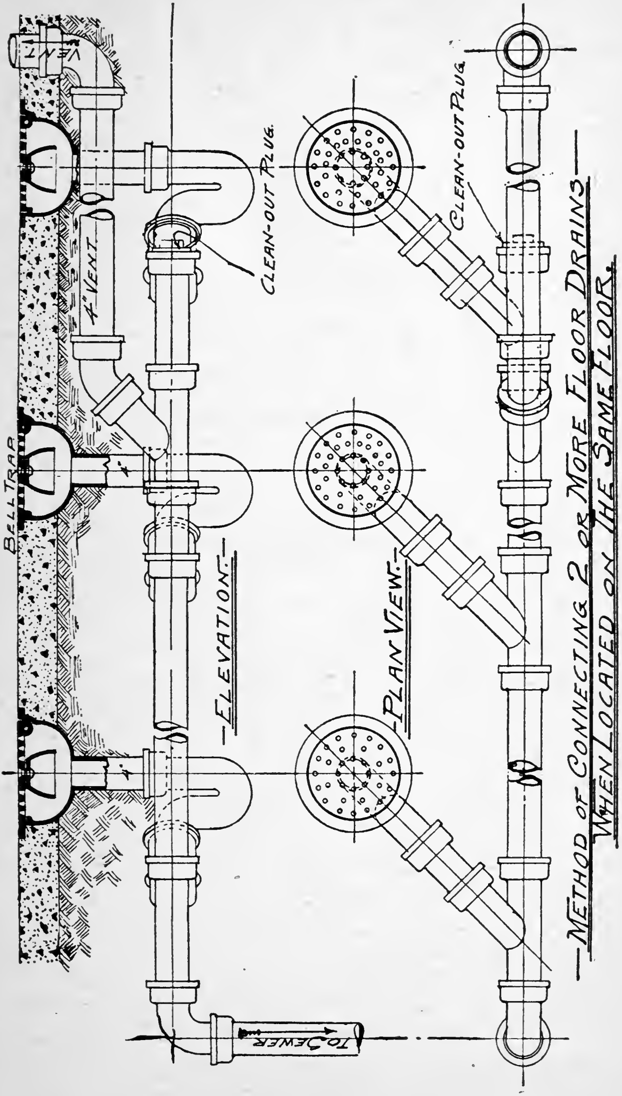
SKETCH No. 1.


4" CLEAN-OUT PLUG
FLOOR DRAIN
SCREEN
BOWL SHAPED RECEPTACLE.
DEEP SEAL TRAP.
WASTE CONNECTION
WASTE CONNECTION.
DEEP SEAL TRAP.
PROPERLY DESIGNED FLOOR DRAINS.
SUPPLY.
DISCHARGE.
SINK
TO SEWER.
DRAIN TILE
WATER EJECTOR.
METHOD OF CONNECTING SUB-SOIL DRAINS WITH SANITARY SEWER.
4" CLEAN-OUT PLUG
EXTENSION NIPPLE
DRAIN TILE.
FLAP VALVE
TRAP

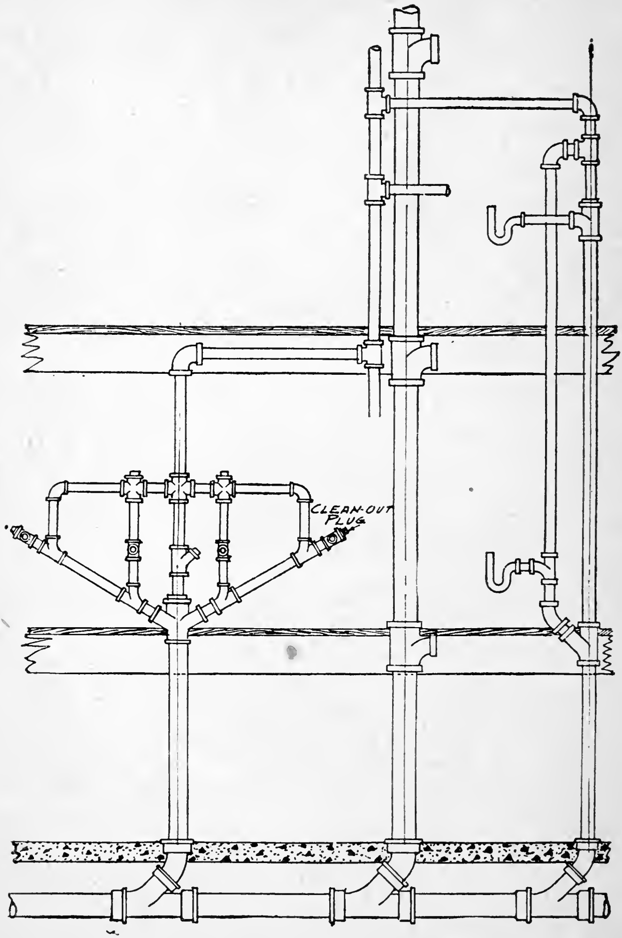
SKETCH No. 2.


THROUGH ROOF
FLOOR DRAIN
JOIST
4"
2" VENT PIPE
4" SOIL PIPE
15'-0" OR LESS.
PIER
WALL
FLOOR DRAIN.
JOIST.
4"
METHOD OF CONNECTING
FLOOR DRAINS ON SEVERAL FLOORS
WITH SOIL AND VENT STACKS.

SKETCH No. 3.

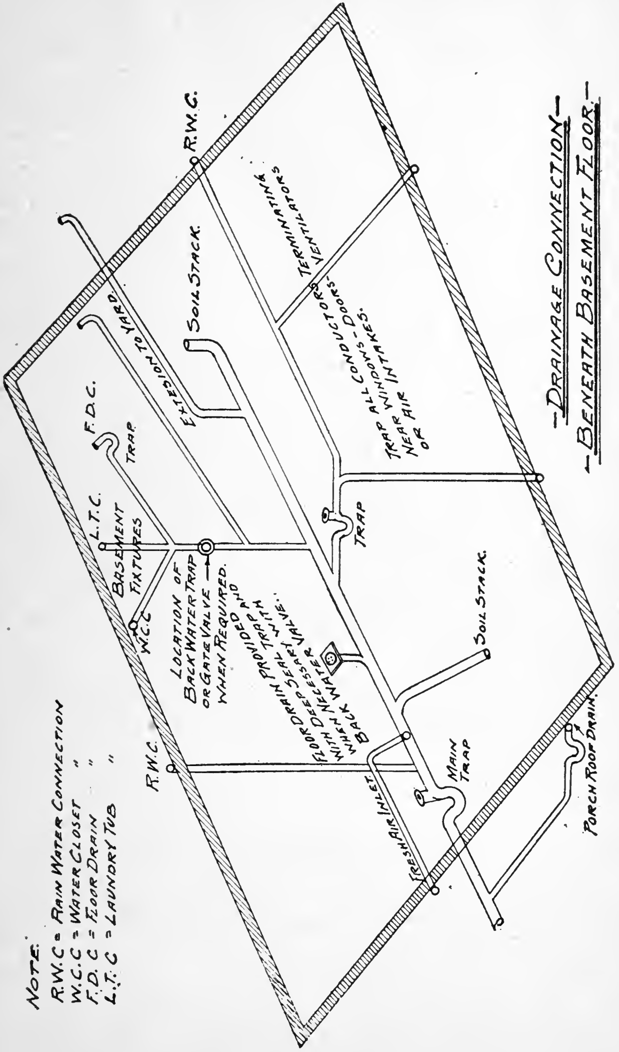

VENT
CLEAN-OUT PLUG
4" VENT
BELL TRAP
4"
4"
ELEVATION
PLAN VIEW
CLEAN-OUT PLUG
TO SEWER
METHOD OF CONNECTING 2 OR MORE FLOOR DRAINS
WHEN LOCATED ON THE SAME FLOOR.

SKETCH NO. 4

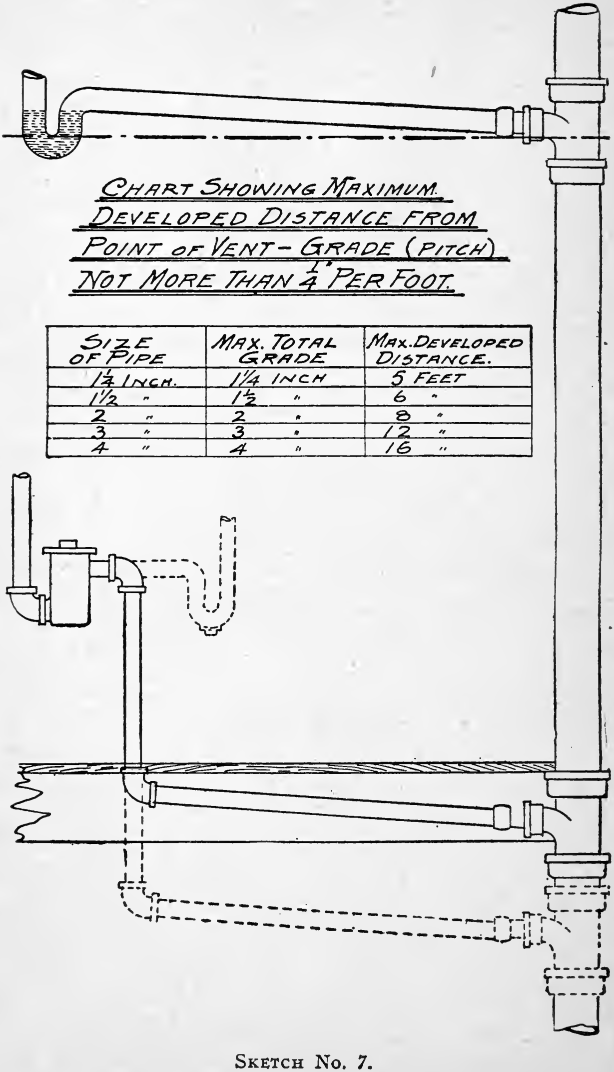


METHOD OF INSTALLING PIPING AND CLEAN-OUT PLUGS FOR URINALS.

SKETCH No. 5.

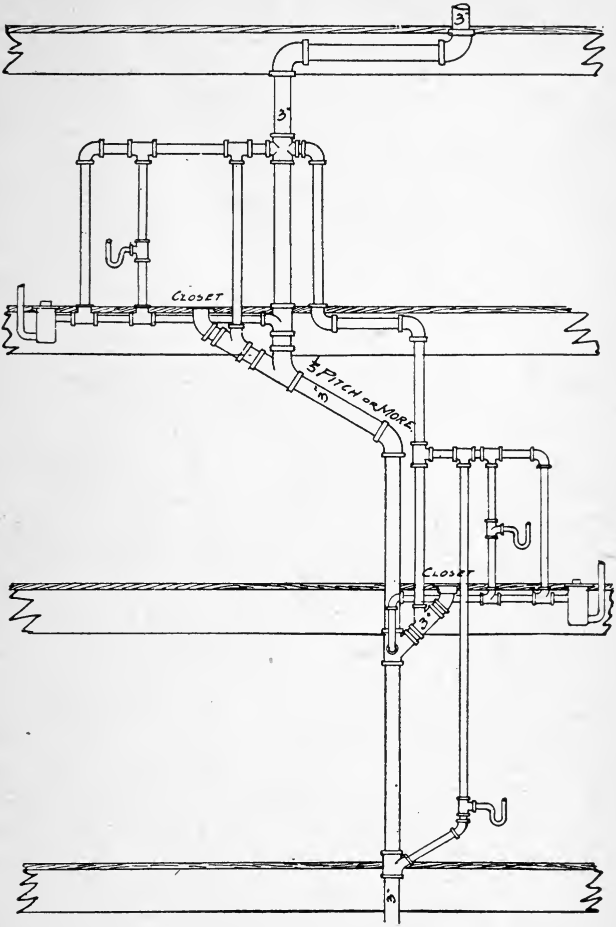

-DRAINAGE CONNECTION-
-BENEATH BASEMENT FLOOR-
NOTE:
R.W.C = RAIN WATER CONNECTION
W.C.C = WATER CLOSET "
F.D.C = FLOOR DRAIN "
L.T.C = LAUNDRY TUB "
R.W.C.
SOIL STACK.
TERMINATING VENTILATORS
EXTENSION TO YARD.
SOIL STACK.
F.D.C.
TRAP
L.T.C.
BASEMENT FIXTURES
W.C.C
LOCATION OF BACK WATER TRAP OR GATE VALVE WHEN REQUIRED.
FLOOR DRAIN PROVIDED AND WITH DEEP SEAL TRAP WHEN NECESSARY WITH BACK WATER VALVE.
TRAP ALL CONDUCTORS- NEAR WINDOWS - DOORS- OR AIR INTAKES.
TRAP
SOIL STACK.
R.W.C.
MAIN TRAP
FRESH AIR INLET.
PORCH ROOF DRAIN.

SKETCH No. 6.



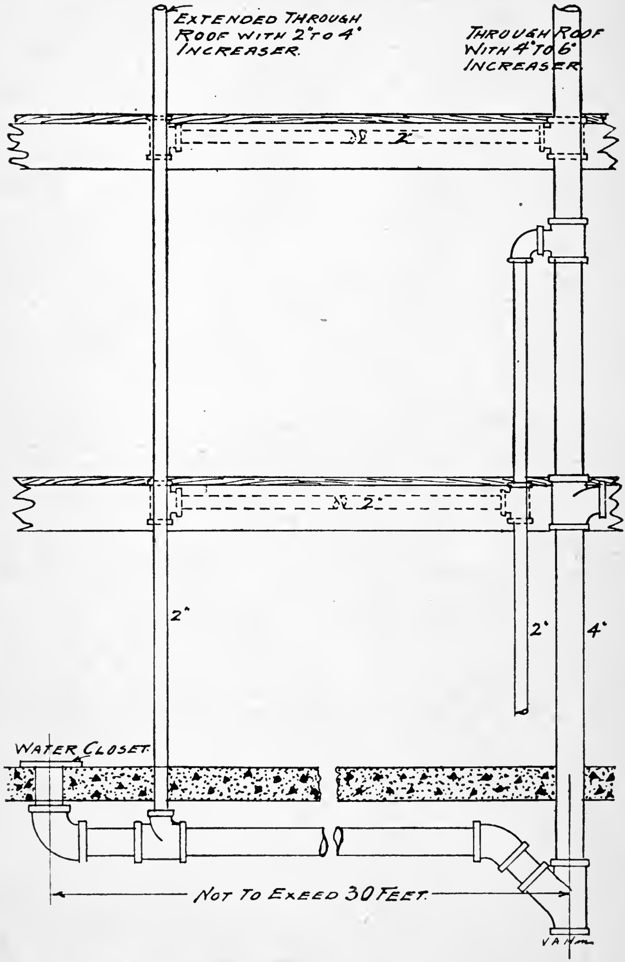
SIZE OF PIPE	MAX. TOTAL GRADE	MAX. DEVELOPED DISTANCE.
1¼ INCH.	1¼ INCH	5 FEET
1½ "	1½ "	6 "
2 "	2 "	8 "
3 "	3 "	12 "
4 "	4 "	16 "

SKETCH No. 7.



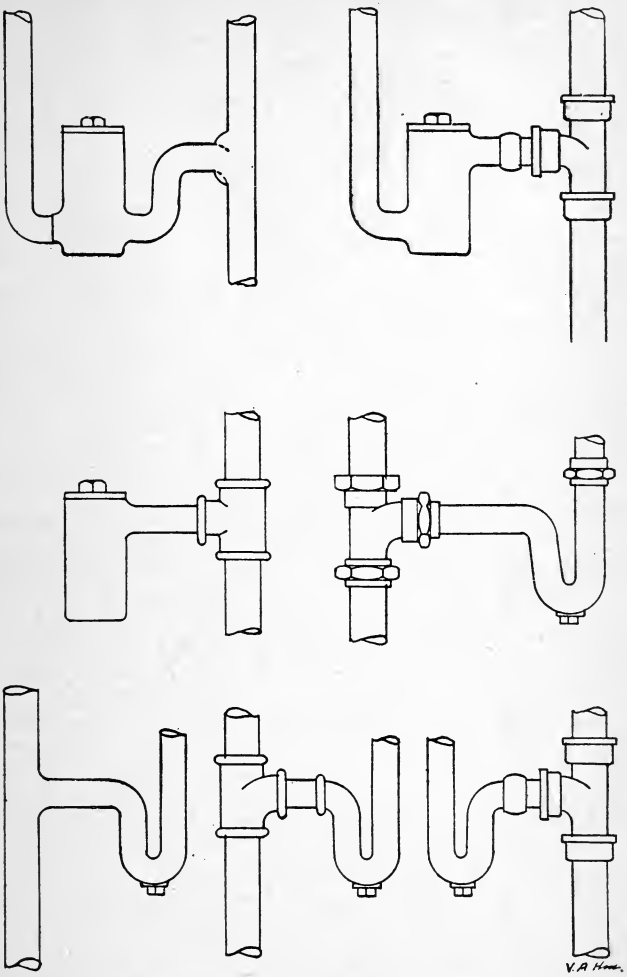
-METHOD OF INSTALLING CLOSETS-
-ON 3" PIPE-

SKETCH No. 8.



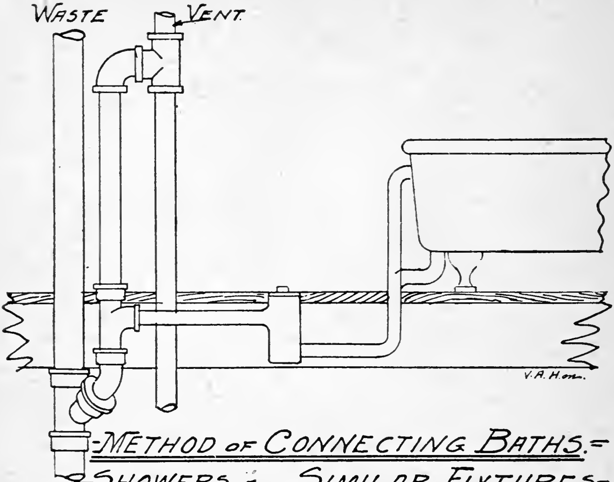
BRANCH SOIL AND WASTE EXTENSION.

SKETCH No. 9.

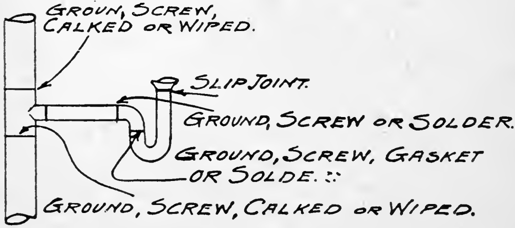


METHOD OF BACK-VENTING TRAPS.

SKETCH No. 10.

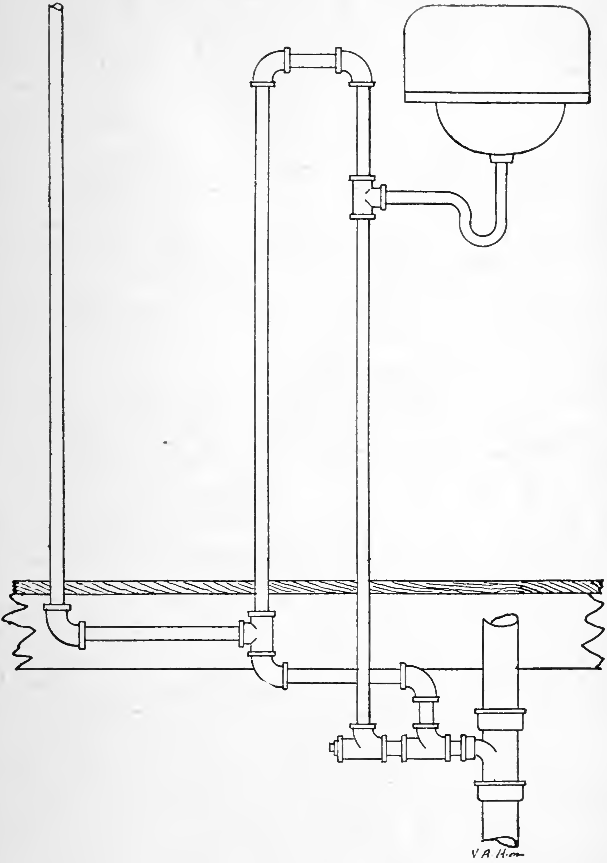


-METHOD OF CONNECTING BATHS.=
-SHOWERS AND SIMILAR FIXTURES-



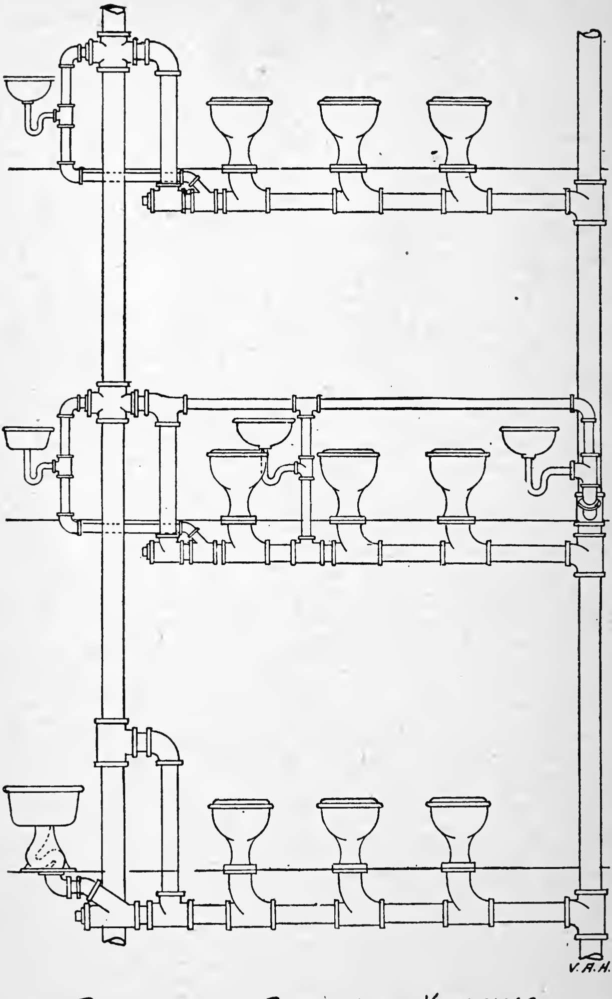
-PERMISSIBLE TRAP JOINTS AND CONNECTIONS.

SKETCH No. 11.



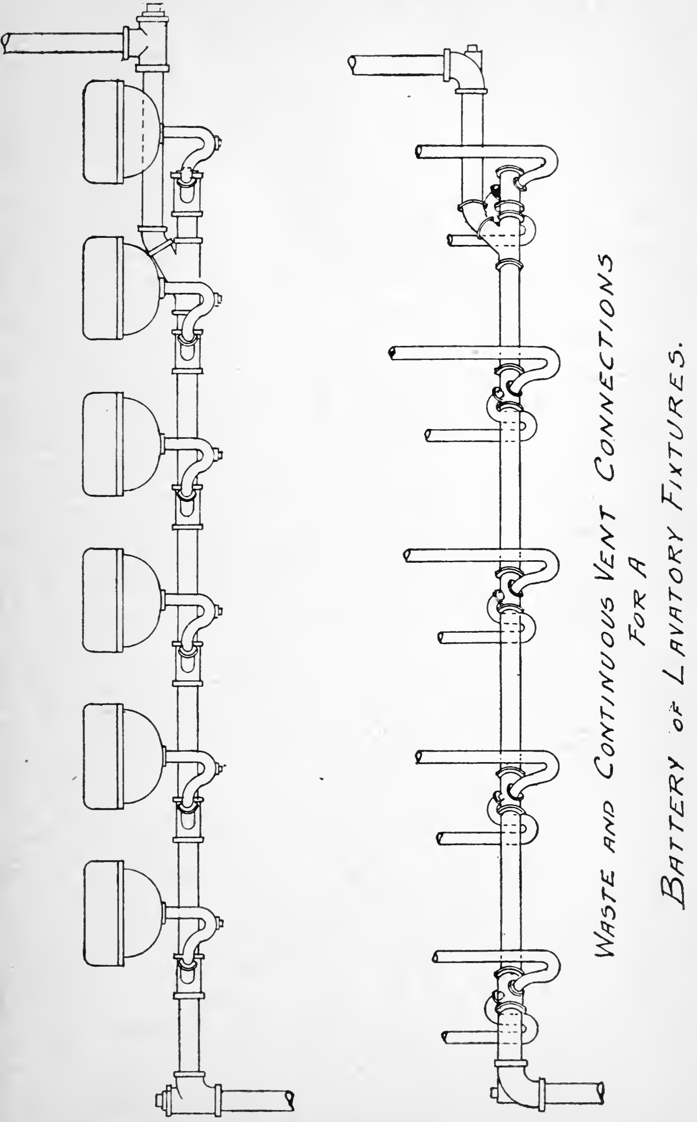
METHOD OF INSTALLING LOOP VENTS.

SKETCH No. 12.

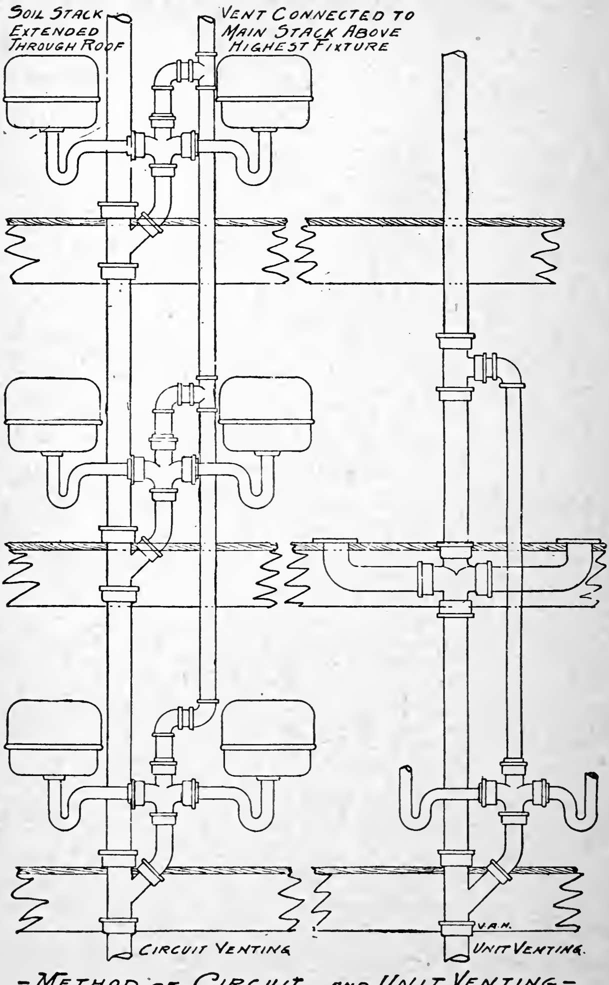


CIRCUIT OR CONTINUOS VENTING

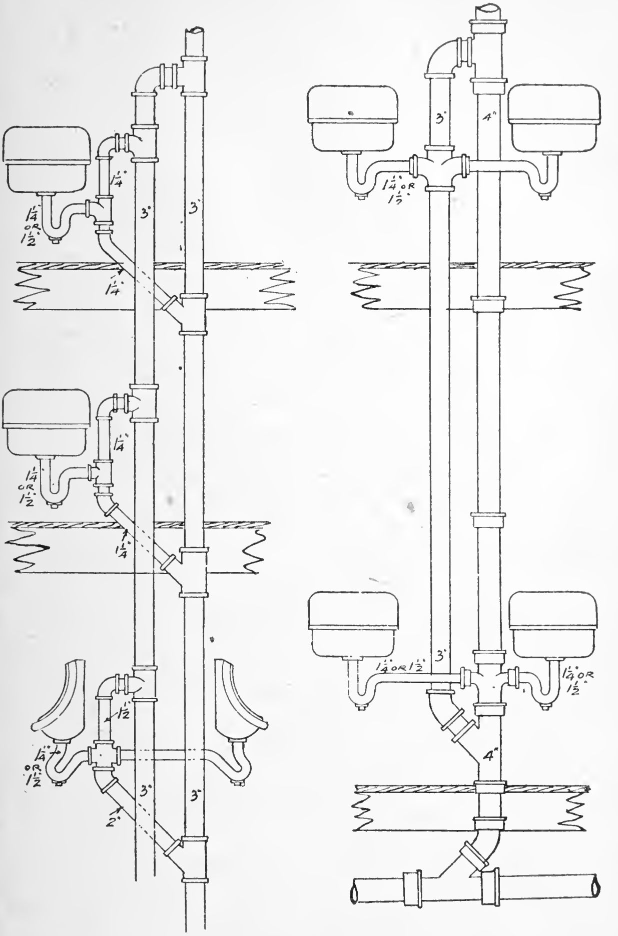
SKETCH No. 13.


WASTE AND CONTINUOUS VENT CONNECTIONS
FOR A
BATTERY OF LAVATORY FIXTURES.

SKETCH NO. 14.

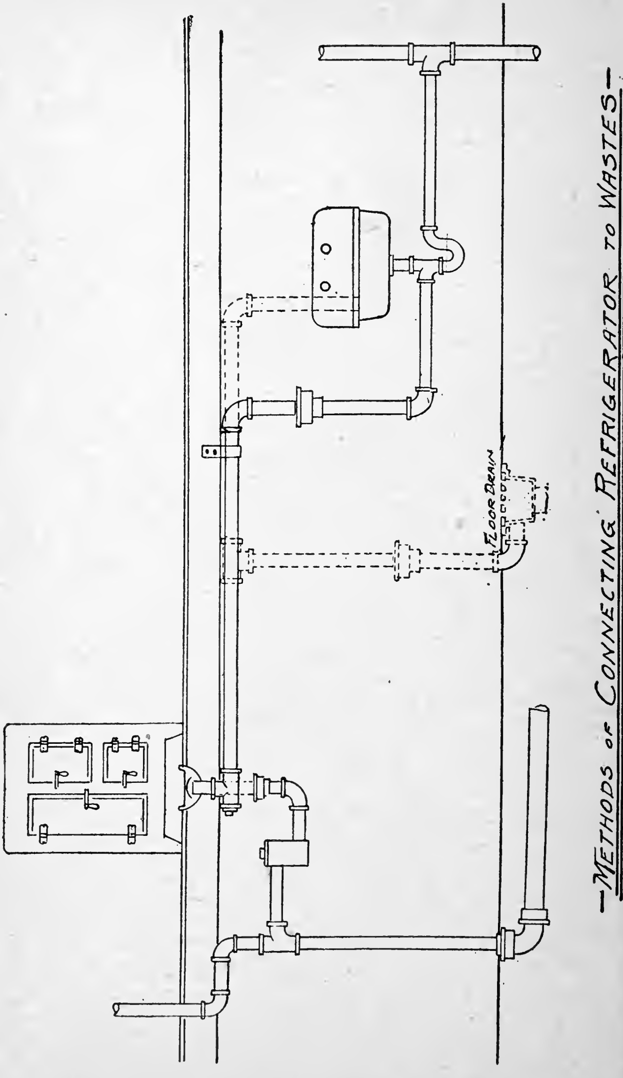

SOIL STACK EXTENDED THROUGH ROOF
VENT CONNECTED TO MAIN STACK ABOVE HIGHEST FIXTURE
V.A.H.
CIRCUIT VENTING
UNIT VENTING.
-METHOD OF CIRCUIT AND UNIT VENTING-

SKETCH No. 15.

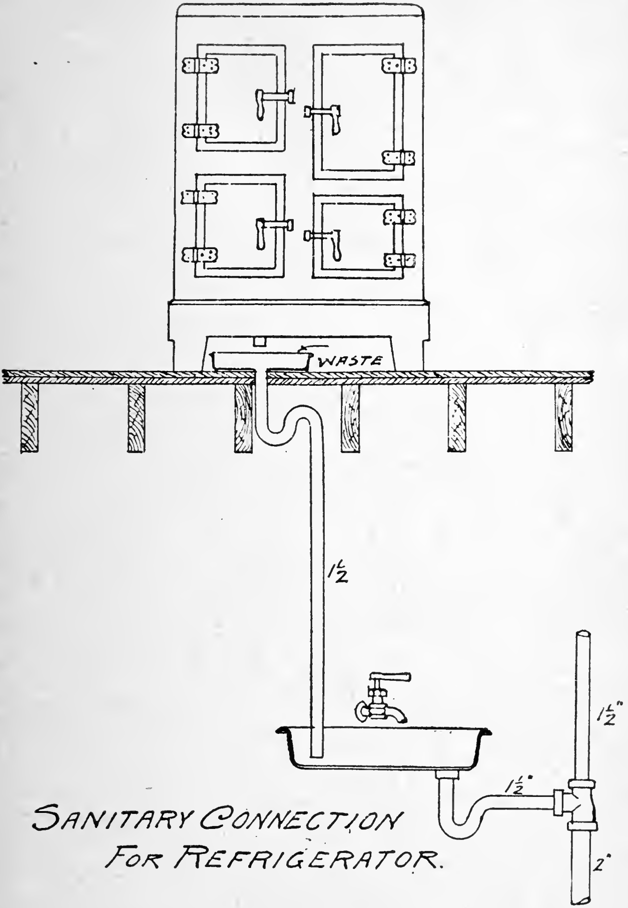


CIRCUIT AND UNIT VENT AND WASTE INSTALLATION.

SKETCH No. 16.

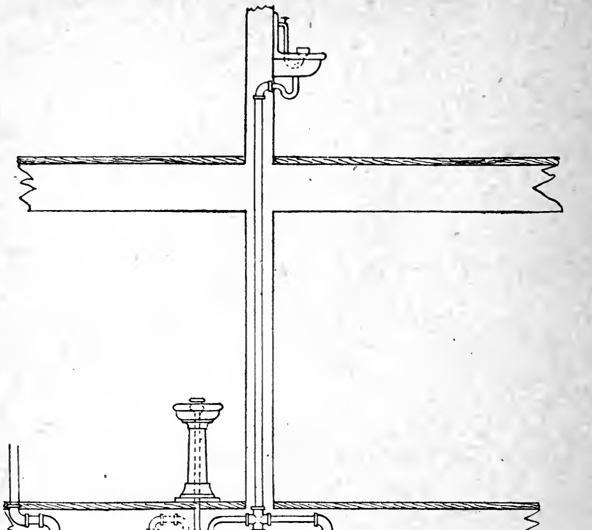


Sketch No. 17.



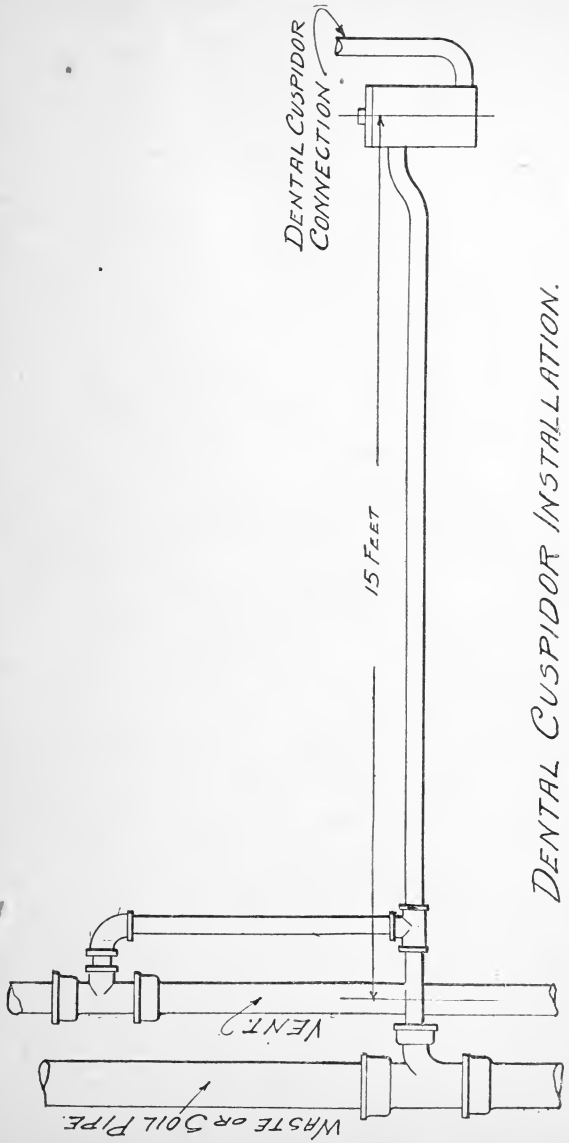
SKETCH No. 17A.

The drainage connections of refrigerators as approved by Pasadena, Calif., chief plumbing inspector.

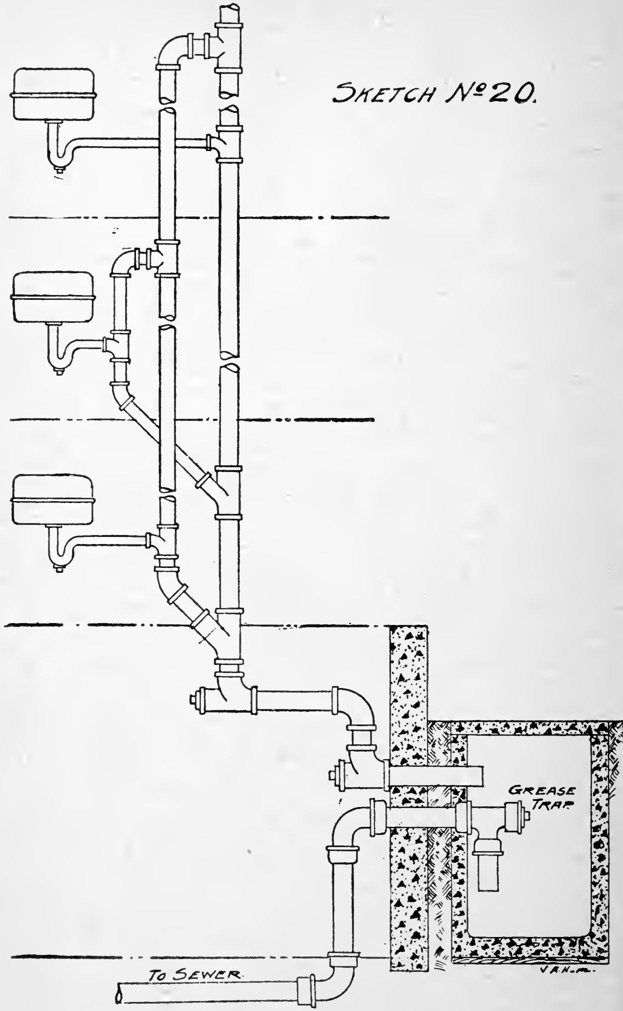


THREE METHODS OF CONNECTING BUBBLER WASTES.

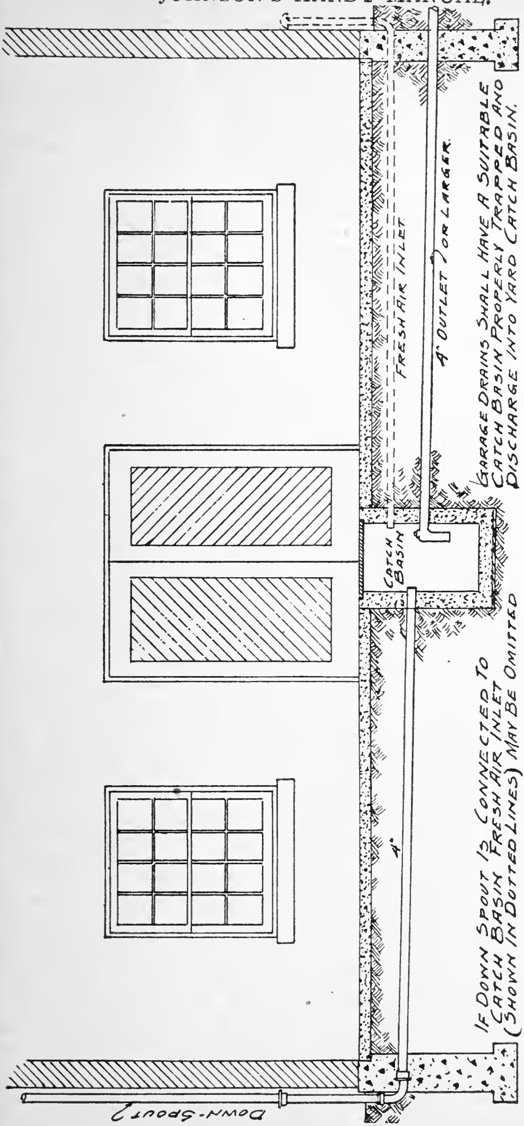
SKETCH No. 18.


DENTAL CUSPIDOR CONNECTION
15 FEET
DENTAL CUSPIDOR INSTALLATION.
VENT.
WASTE OR SOIL PIPE.

SKETCH No. 19.

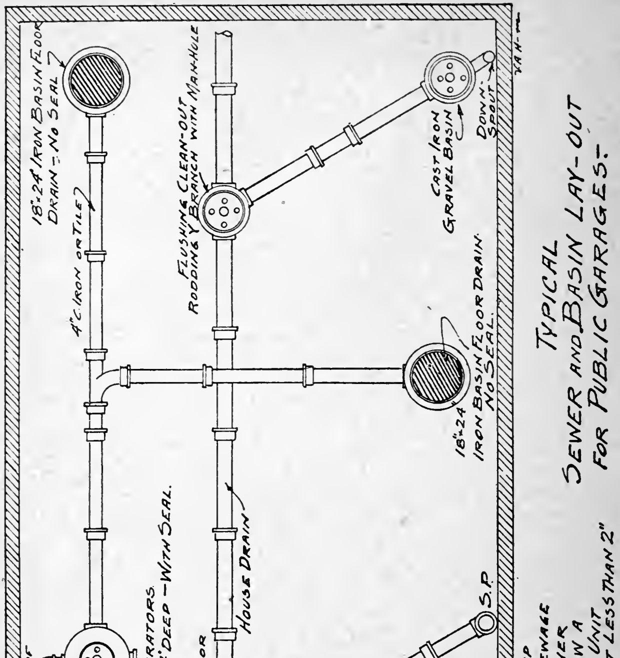


METHOD OF CONNECTING SINK WASTE TO GREASE CATCH BASIN

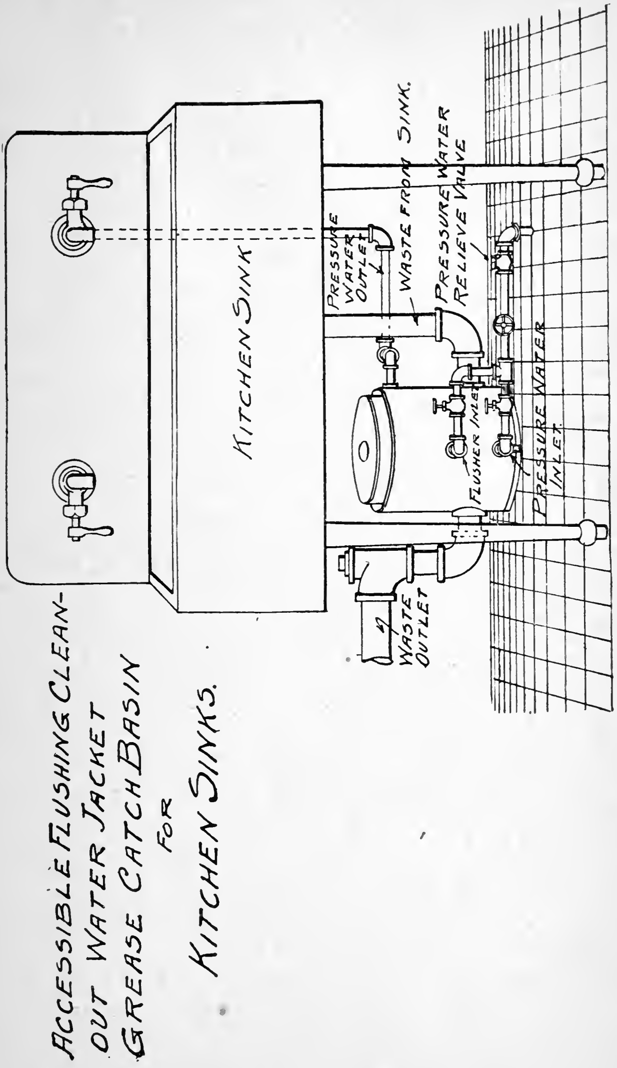


METHOD OF INSTALLING GARAGE CATCH BASINS

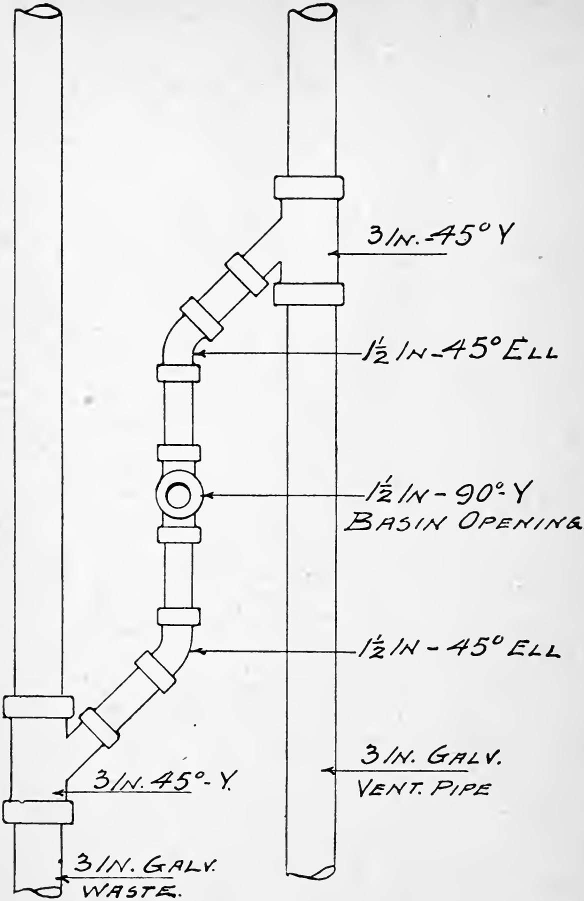
SKETCH No. 21.


18"×24" Iron Basin Floor Drain—No Seal
4" C. Iron or Tile
Flushing Clean-out Rodding Y Branch with Man-Hole
Cast Iron Gravel Basin
Down-Spout
18"×24 Iron Basin Floor Drain No Seal.
Typical Sewer and Basin Lay-out for Public Garages.
Vent to Roof
2" Iron
2" Iron.
Gasoline and Oil Separators. Cast Iron Basins 18"×24" Deep—With Seal.
6" Iron or
House Drain
S.P.
6" Iron or Tile
6" Iron or Tile
Flushing Clean-out Rodding Y Branch with Man-Hole
Requirements: Triple 18"×24" Deep C.I. Catch Basins Through Which All Sewage Shall Pass Before Entering City Sewer Each Unit Shall Be Trapped So to Allow a Water Seal of Not Less Than 10"— Each Unit To Be Connected to a Vent Pipe of Not Less Than 2"

Sketch No. 22.

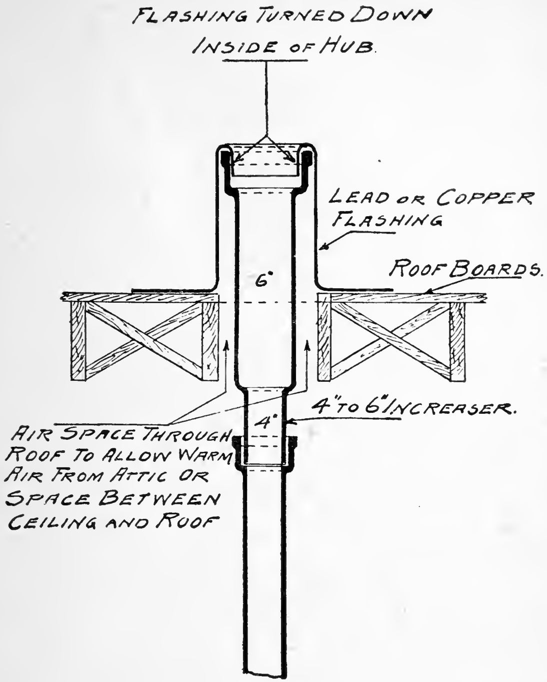

ACCESSIBLE FLUSHING CLEAN-
OUT WATER JACKET
GREASE CATCH BASIN
FOR
KITCHEN SINKS.
KITCHEN SINK
PRESSURE WATER OUTLET
WASTE FROM SINK.
PRESSURE WATER RELIEVE VALVE
FLUSHER INLET
PRESSURE WATER INLET
WASTE OUTLET

SKETCH No. 23.



—PROPER WAY OF ROUGHING-IN—
-WASTE AND VENT FOR LAVATORIES.-
—FOR OFFICE BUILDINGS.—

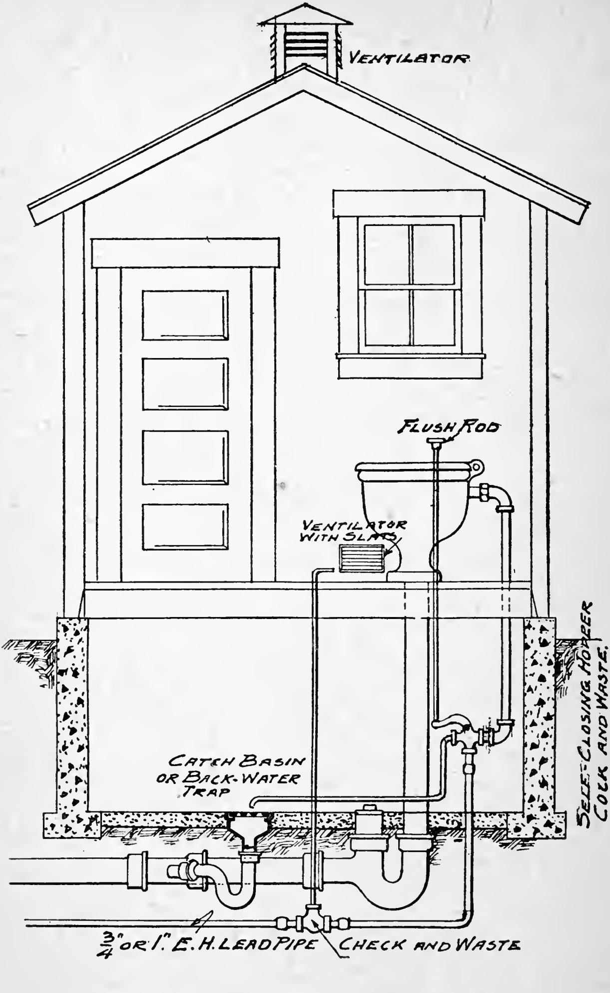
SKETCH No. 24.



—J. W. JOHNSON'S.—

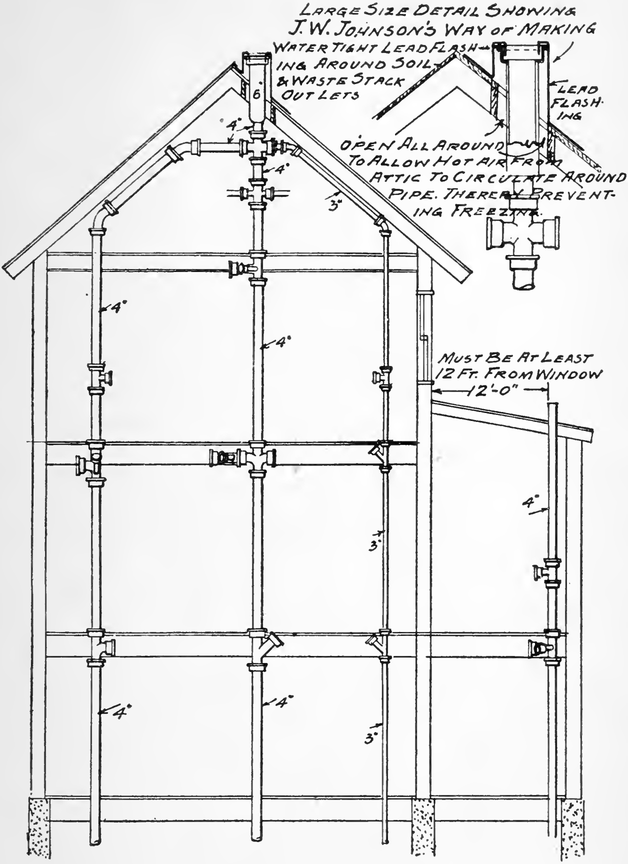
—PROPER WAY TO FLASH SOIL AND VENT PIPES—
—AT ROOF TO PREVENT FREEZING.—IT ALSO—
MAKES A PERFECTLY WATER PROOF JOB.

SKETCH NO. 25.



METHOD OF INSTALLING OUT-DOOR FROST-PROOF CLOSET.

SKETCH No. 26.



METHOD OF CONNECTING VENT AND JOINING OF SOIL AND WASTE PIPE STACKS.

SKETCH No. 27.

Questions and Answers for Master Plumbers and Journeymen.

Most large cities and a few states have departments for examining those who feel themselves competent to pass an examination in the plumbing trade. Not only this, but each has a law requiring every member of the trade to pass such examination before he is allowed to ply his trade in that particular city or state.

As a rule these examinations are based on principles similar to the table given below.

Subjects	Relative Weight	Mark Possible	Passing Mark
1. Experience	1	10	7
2. Written questions..	4	40	28
3. Chart	2	20	14
4. Practical work	3	30	21
Total.........	10	100	70

The following questions are typical of those asked everywhere in both Master Plumber and Journeymen Examinations and the answers for same here given are correct.

QUESTIONS FOR MASTER PLUMBERS' EXAMINATION.

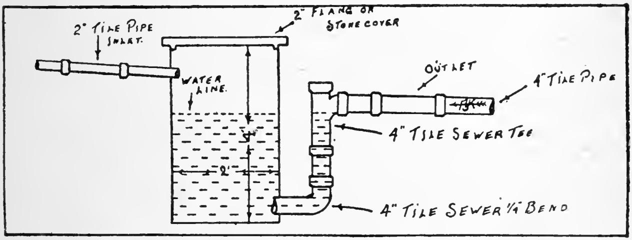
1. What are the duties of a plumber? (b) Give a list of such tools as are necessary, indispensable and peculiar to the plumbing business.

1. It is the duty of a plumber to furnish and erect lines of suitable piping to furnish houses, dwellings, public buildings, villages, towns, cities, etc., with a pure, wholesome and copious supply of water for drinking, cooking, bathing, waste disposal, fire and other domestic purposes. To furnish and erect suitable fixtures, pipes and appliances to receive conduct and dispose of all waste of houses, dwellings, buildings, stables, cities, etc., in such a manner as

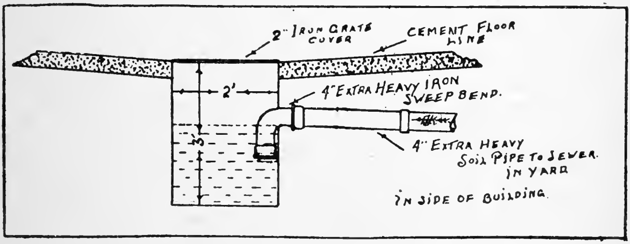
to be perfectly sanitary and not to endanger the health of the public. (b) Shave hook, turn pin, soldering iron, tap borer, bending springs, wiping cloths, drift plugs, basin wrench.

Q. 2. Illustrate the most effective type of commercial grease trap; (b) where should it be used? (c) what causes the grease to collect in trap?

A. 2. On waste pipes from sinks. (c) When hot grease is discharge into a waste pipe it tends to congeal and collect on the sides of the pipe. In time this grease chokes the waste pipe and as it is impossible to clean it from the pipes without taking the pipes apart, a grease trap is used to congeal and intercept the grease before it enters the waste pipe.



Q. 3. Illustrate how you would design garage drainage to prevent volatile oils from getting into main sewers.

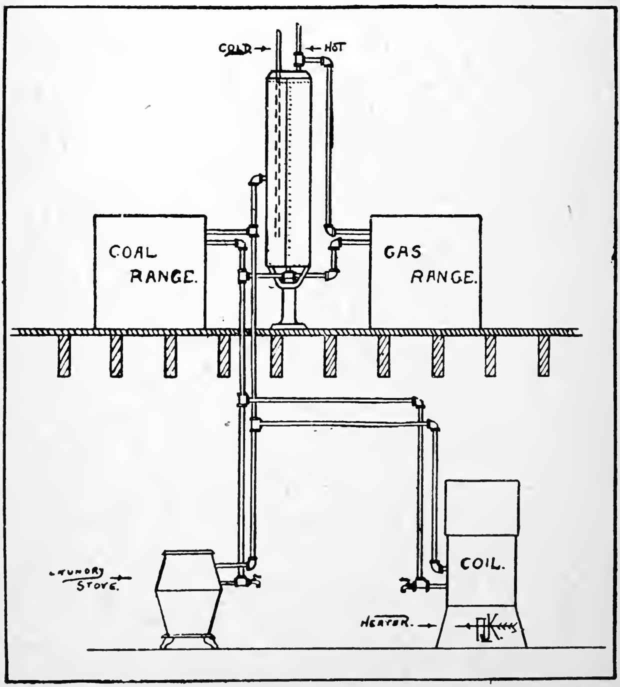


Q. 4. State basis upon which you determine the sizes of water pipe for a domestic supply to a large number of fixtures.

A. 4. The size depends entirely upon the number and kind of fixtures to be supplied, the length of the pipe, the number of fittings, the pressure and the number and size of the branches.

Fixture.	Sizes.
Kitchen sinks	½ in.
Pantry sinks	⅜ in.
Laundry trays	½ in. or ¾ in.
Water closets	⅜ in.
W. C. Flush valve	1 in. up
Basins	⅜ in.
Baths	½ in.
Slop sinks	½ in.
Urinals	½ in.
Range boiler	½ in. or ¾ in.
Foot baths	½ in.
Sitz baths	½ in.

5. Sketch a practical system for connecting up a coal range, gas range, laundry stove and coil in heating apparatus.



6. What general and necessary items should comprise an estimate for the installation of a plumbing system? (b) If an article lists at $80.00 plus 20% with a discount of 10-5% and a cash discount of 2% if paid in ten days, what would be the net amount of your check if you paid for it in nine days from date of invoice?

6. Sewer pipe and fittings, grease trap and fittings, paving permits, corking lead, solder, roof flashings, tap service pipe and permits, standard and extra heavy soil pipes and fittings, lead pipe (all sizes), water and waste pipes, brass goods, stop cocks, sill cocks, faucets, soldern nipples, brass furrows, lead bends, drum traps, fixtures, closets, baths, basins, sinks, range boilers, laundry tubs, galvanized pipes and fittings. **Answer** to problem, $80.44.

7. (a) What is a check valve? (b) What is a ball cock?

7. A check valve is a form of valve which permits a flow of water through it in one direction only, its action being automatic. Check valves are made in several styles and are termed globe or horizontal, angle, vertical and swing check valves, according to their construction. The swing check valve is preferable for use on water pipe as it has a full sized waterway. (b) A ball cock is a compression cock or faucet operated by a rod and hollow globe or ball which floats on the surface of the water. This cock is used to automatically supply cisterns and tanks with water. The ball is called a float.

8. What is the circulation pipe?

8. With fixtures that are a considerable distance from the range boiler when a hot water faucet is opened, the water in the pipe between the boiler and fixture must be drawn off before hot water can be obtained, which causes a loss of both water and time. To overcome this, a pipe is connected to the hot water supply pipe at a point near the fixture and returned back to the boiler, connecting at the lower coupling. The hot water circulates through these pipes and makes it possible to obtain hot water the instant the faucet is opened. The special pipe employed to make this possible is called the circulation pipe.

9. What is a soil pipe or stack? (b) Give sizes.

9. A soil pipe or stack is the vertical line of pipe extending from it's connection with the house drain up through the building and receiving the waste from water closets with or without that of other fixtures. A soil stack should never be less than 4 inches. It may be of cast iron or galvanized wrought iron. Connections can be made to the soil pipe with Y branches or T-Y branches. Offsets should be avoided as much as possible. If horizontal runs are necessary table gives the sizes of soil pipes found by experience to give good results. (b) Sizes of soil pipes.

Size.	Number of Fixtures.
4 inch	1– 15
5 inch	16– 30
6 inch	31– 50
7 inch	51– 80
8 inch	81–120
9 inch	121–200
10 inch	201–300

10. Illustrate by a single line drawing how you would design a waste line properly vented accommodating a sink in basement, a sink and lavatory on first floor and a closet and bath tub on second floor.

See Fig. A on the following page.

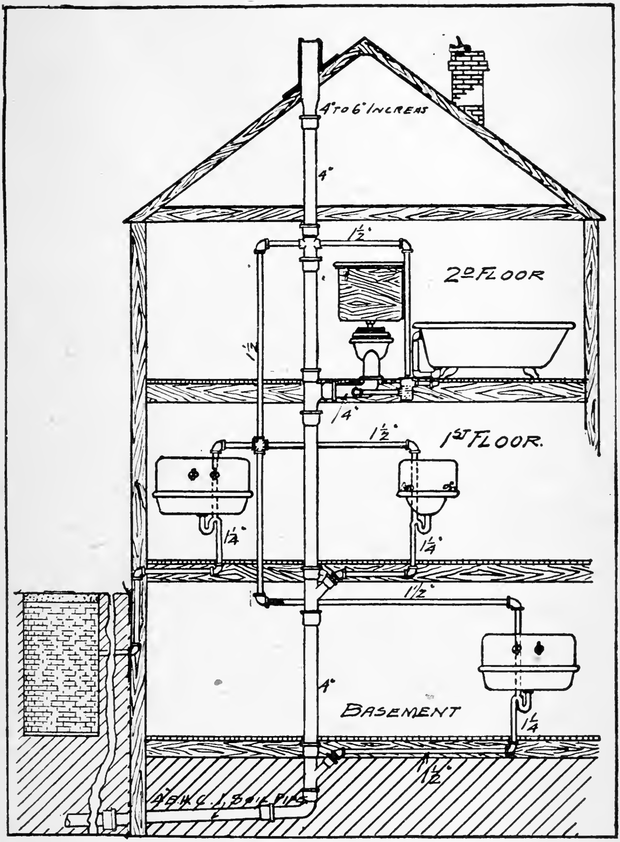

4" TO 6" INCREAS
4"
1½"
2ND FLOOR
1¼"
1½"
1ST FLOOR.
1¼"
1¼"
1½"
4"
BASEMENT
1¼"
1½"
4" B.H.C.I. SOIL PIPE

Figure A.

Questions for Journeyman Plumbers' Examination.

Q. 1. Would you install a main waste or a long branch waste line without extending it to the outer air at the top? Give your reason.

A. 1. No. It would cause syphonage. By referring to an "S" trap it will readily be seen that the outlet forms a perfect syphon, the part of the trap between the dip and the outlet forming the short side and the waste pipe from the outlet downward forming the long side. When a large quantity of water is discharged from the fixture into the trap, the water fills the entire trap and waste pipe for some distance below the trap. It is seen that the weight of water is much greater in the outlet side than in the inlet side of trap and it tends to cause the water in the trap to rise to the outlet and follow the larger body of water in the waste pipe, leaving the trap without any water to form its seal.

Q. 2. How and with what material would you construct a cesspool.

A. 2. Leaching cesspool. Brick, laid up dry. A leaching cesspool is merely a hole in the ground, the walls being walled up dry without the use of cement. The top is covered with timbers or arched over and covered with a foot or so of earth.

Q. 3. Why are brass connections used in joining lead wastes to iron ones instead of connecting direct.

A. 3. A soldering ferrule, bell shaped, is used to join lead wastes to iron ones. It is used to make proper connections between cast iron pipe and lead pipe by means of wiped solder and lead calked joints. All ferrules should be at least 4 inches long.

Q. 4. (a) What is a range boiler tube? (b) What is it for?

A. 4. (a) It is a small tube generally ½ inch or preferably, ¾ inch for 30 to 40 gallon boilers, and connects with the cold water supply at the top boiler coupling and extends down through the boiler to a point below the side coupling and above the water-back. (b) To prevent the water being syphoned out of the boiler.

Q. 5. What is a by-pass as applied to drainage?

A. 5. A by-pass as applied to the drainage, venting, etc., of buildings is an arrangement by which sewer

gas has access into a building from the soil, waste or vent pipes without passing through a trap seal. By-passes are generally the work of careless or ignorant plumbers, who do not understand the theory of their trade.

Q. 6. What metals are used and in what proportions for soldering joints in waste pipes? Would you use the same solder for joints in lead water pipes? Give your reason.

A. 6. Tin and lead, two parts lead and one part tin. No, it is too coarse, add more tin, it makes it a stronger and tighter joint. It is composed of 3 parts lead and 2 parts tin.

Q. 7. What is the proper way to connect a water closet to the lead bend?

A. 7. There are a great number of different methods employed, only three of which are used to any extent. The cheapest form of connection is made by tafting the lead bend, fastening the bowl by screwing it to the floor. This method of connection while used to a great extent on country work is a very poor one and is open to many objections. A better connection is made by soldering a brass floor flange to the lead bend where it projects through the floor; a rubber gasket is placed on the flange, the annular space in the base of the bowl is filled with a mixture of white lead and shellac and the bowl set down on the flange and gasket, forcing it down so that the white lead and shellac will fill all the interstices and make a water and gas tight joint. The closet should be fastened with the bolts that accompany the flange. Putty is sometimes substituted for the white lead and shellac, but does not make as reliable a joint. A connection used very extensively in New York City is the screw connection. A metallic nipple, having a male or outside thread is made in the outlet of the closet bowl, being made tight with a special cement. A brass socket having a female or inside thread is soldered to the lead bend and the closet screwed down into this piece. This connection is very rigid and sometimes breaks the bowl.

Q. 8. What provision, if any, would you take to make it convenient to clean out soil or waste pipes in the event of stoppage of same?

A. 8. Cleanouts should be provided at the connection of all branches, at points not over 50 feet apart on straight runs and at the end of the line.

Q. 9. Whe it is desired to wipe a joint on a pipe through which the water cannot be shut off tight, what is done to keep the pipe dry long enough to wipe the joint?

A. 9. The joint should be prepared, the solder heated and everything in readiness for wiping. Force some dry bread into the pipe and wipe the joint as quickly as possible. The bread will absorb the water and keep the pipe dry until the joint is made if the work is done quickly. If the pipe is short it is sometimes possible to insert a rubber tube into the pipe and carry the water past the joint.

Q. 10. (a) What is a flux? (b) Name some of the fluxes.

A. 10. (a) A flux is a substance either liquid or solid used to facilitate the fusing and uniting of two metals when soldering. (b) Rosin, mutton tallow, muriatic acid, chloride of zinc, sal-ammoniac, etc. There is also a number of patented fluxes on the market.

Q. 11. How can the flaws in cast iron soil pipe resulting from casting the pipe in a horizontal position be detected without cutting the pipe?

A. 11. The uneven thickness shown on the surface of the pipe can be detected by rubbing hands over it.

Q. 12. Suppose that while working on a job some brass filings should get into your wiping solder; what would be the result and how would you remedy it?

A. 12. It would be coarse; burn it out with sulphur and then refine it with rosin.

Q. 13. What are soil and waste vents?

A. 13. A system of pipes preventing syphoning of traps.

Q. 14. What pressure should exist in a plumbing system?

A. 14. Sufficient pressure to bring the water to all fixtures, or about thirty pounds.

Q. 15. Under what condition may earthenware pipe be run inside of foundation wall?

A. 15. Under such conditions that settling of building cannot injure pipes.

Q. 16. Why is a lead connection used for service pipes next to street main?

A. 16. Lead being flexible, prevents breaks through settling or expansion of building.

Q. 17. What is ventilation?

A. 17. A system for supplying fresh air in rooms and removing odors from waste pipes.

Q. 18. How is syphonage a detriment to plumbing work?

A. 18. It breaks the seal of traps and drains range boilers if not properly installed.

Q. 19. How would you revent a basin located in the center of a room?

A. 19. By running a vent from wall to fixtures under the floor and installing in such a manner as not to trap it.

Q. 20. What is fluid friction?

A. 20. Friction of fluids in pipes causing loss of pressure.

Q. 21. What is the objection to using wrought iron pipe for waste and vents?

A. 21. Wrought iron pipe rusts, stops the circulation of vents and will leak after being used a short time.

Q. 22. What is a by-pass in regards to plumbing?

A. 22. A combination of pipes and valves used to prevent stoppage of system when fixtures like meters and filters are not used.

Q. 23. What are soil and waste vents?

A. 23. System of pipes and piping to prevent sewer gas to enter building.

Q. 24. What is the object in connecting vents into main stack below fixtures?

A. 24. To admit air to the drain pipes and sewer to prevent the formation of rust and scales.

Q. 25. How is sewerage disposed of that is below the level of the sewer?

A. 25. By the use of bilge pumps.

Q. 26. What are the comparative advantages of the S and the Drum trap?

A. 26. Both are useful in their places. A drum trap is more preferable on account of the larger quantity of water it holds and the four-inch opening it has for cleaning out purposes.

Q. 27. What is the chief advantage claimed for the Durham system?

A. 27. It gives a smooth, unobstructed water passage and the joints are not loosened by vibration.

Q. 28. What are the requirements of a toilet room?

A. 28. Water, wastes and ventilation.

Q. 29. Why may a syphon water closet not be vented from the crown of the trap?

A. 29. It will break the syphon to prevent breaking the trap seal.

Q. 30. How is syphonage a great benefit in plumbing?

A. 30. It is necessary for flushing and scouring the fixture.

Q. 31. How do you take a 45-degree pipe measurement?

A. 31. Figure the square root of angles.

Q. 32. Can hot water tanks be heated by water front and steam coils at the same time?

A. 32. Yes, if continual use is made of the hot water.

Q. 33. What advantage is gained in connecting the flow pipe from water front into the hot water pipe above boiler?

A. 33. The hot water can be had sooner.

Q. 34. Name causes of poor circulation between boiler and water front.

A. 34. If the pitch is not right or the pipes stopped by stone from water or scale.

Q. 35. How might it be possible to draw hot water from a cold water faucet?

A. 35 When boiler is overheated the steam will back the water in the cold water pipes.

Q. 36. What is air-lock?

A. 36. Air between trapped pipes preventing circulation.

Q. 37. Why should traps in both hot and cold water pipes be avoided?

A. 37. Because better circulation of the water will result.

Q. 38. Can range boilers be syphoned?

A. 38. Yes, if the tube of cold water supply has no vent opening.

Q. 39. How should large hot water tanks be suspended from cellar timbers?

A. 39. With good bolts and bands of iron.

Q. 40. What is the best method of avoiding air-lock at high point of piping when boiler is heated by water front above it?

A. 40. By taking off supply to fixture on highest point of hot water pipe.

Q. 41. Give your idea of theory of ventilation, as practiced in plumbing work.

A. 41. Have stacks large enough to allow fresh air free circulation and revent properly to prevent syphoning of fixture traps.

Q. 42. Tell the difference between weight and pressure in a pipe 60 feet high, full of water.

A. 42. Thirty pounds.

Q. 43. Can a pipe be filled with water through tight connection, both ends being closed with a pressure of 60 pounds?

A. 43. No.

Q. 44. Are all gases lighter than air.

A. 44. No.

Q. 45. Give name of some gas that is heavier than air.

A. 45. Carbonic dioxide.

Q. 46. Explain the heating of water in a boiler and causes for circulation.

A. 46. Water being heated expands causing it to become lighter than cold water which causes circulation.

Q. 47. Explain syphonic action, how caused and the effect produced and how it can be avoided.

A. 47. Water rushing in a pipe causes a vacuum. The air pressure forcing the water in the vacuum causes a syphon, which can be prevented by venting the inlet of air, breaking the vacuum.

Q. 48. What is water composed of?

A. 48. "H_2O"—2 parts hydrogen, 1 part oxygen.

Arco Wand Vacuum Cleaner.

Wiring Chart Should Be Sent With Each Machine.

All that is required of the trade in the matter of electric installation is to obtain from the local electric power station the information as to whether direct or alternating current is to be used. If it is direct current, ascertain the voltage; or if it is alternating current, the voltage, phase and cycles. When this information is sent to us, a correct wiring chart to apply exactly to the conditions is sent with the vacuum cleaner, making it a very easy matter for the electrician to make proper wiring connections. The wiring charts here inserted show the completeness of the information we furnish with each machine.

Wiring Diagrams of Alternating Current Single-Phase Installations With Remote Control for ½, ¾, 1½ and 2 Horse Power Motors.

Note. Motors are installed without starting box. Direct current, motors are series wound with enough shunt winding to prevent racing under no load conditions.

Note A. Switches No. 1 and No. 2 are three-way snap switches. A control circuit of this nature consists primarily of two (2) three-way switches and if more control points are needed, four-way switches will be connected between the two three-ways, i. e., if four control points are wanted two (2) four-way switches will be connected between two (2) three-way switches.

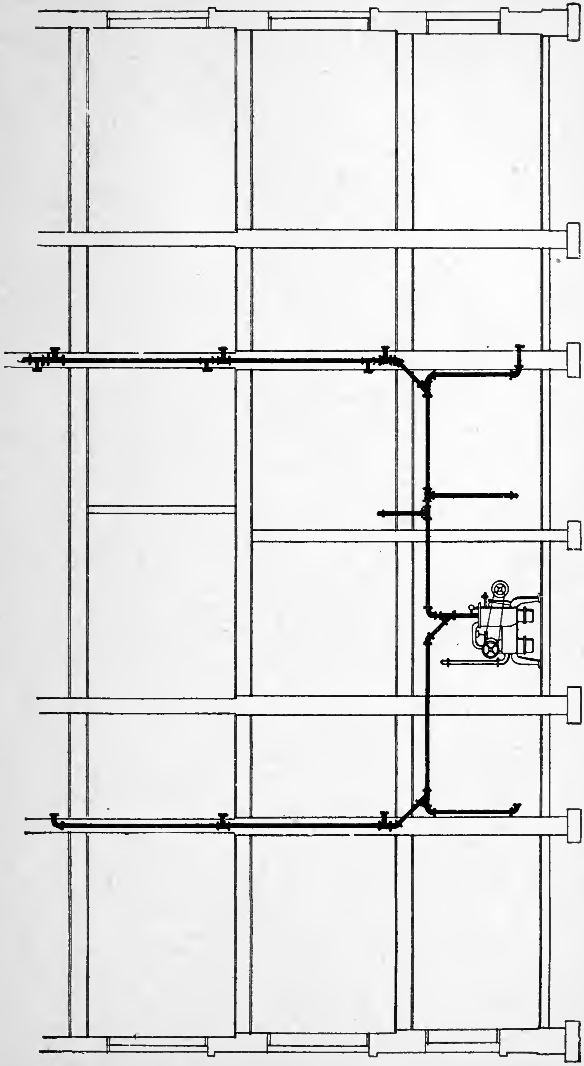
Note B. Switch No. 1 must be located not to exceed 4 feet from vacuum cleaner relief valve so that both can be reached at the same time.

Note C. If metal conduit is used draw all three control wires into one conduit.

Wiring Diagrams of Alternating Current Single-Phase Installations With Remote Control for ½ and ¾ Horse Power Motors.

Note. Motors are installed without starting box. Direct current, motors are series wound with enough shunt winding to prevent racing under no load conditions.

Be careful to connect proper switch terminals to motor and line leads. Failure to do this will result in short circuiting line if two or more switches are closed at one time. One of these switches must be located not to exceed 4 feet from vacuum cleaner re-



TYPICAL LAY-OUT OF ARCO WAND VACUUM CLEANER.

lief valve so that both can be reached at the same time. If motor is connected for 220 volts, ten (10) ampere double pole flush switches to be used. If motor is connected for 110 volts, twenty (20) ampere double pole rotary surface switches to be used.

Sizes of Pipe.

With Nos. 460, 461 and 462 Arco Wand Vacuum Cleaners, 1½-inch pipe can be used where distance from machine to most remote inlet coupling does not exceed 60 ft.; 2-inch pipe can be used where distance from machine to most remote inlet coupling, with No. 461, does not exceed 250 ft., and with No. 462 does not exceed 350 ft. In such runs of 2-inch piping, 1½-inch pipe can be used for 60 ft. from remote inlet couplings toward the machine, using 2-inch pipe for remainder of distance. Thus, risers in any building less than 60 ft. in height can be made of 1½-inch pipe, using 2-inch pipe for horizontal mains in basement. The exhaust pipe for each of these machines should be 2-inch pipe.

Installing Inlet Couplings.

First. After applying lead or pipe-joint paste to the male thread of the inlet coupling bushing, screw it into the opening of the drainage fitting as far as possible, using the Arco Wand wrench.

Inlet Coupling in Place.

Second. After applying lead or pipe-joint paste to the male thread of the inlet coupling, start it into the thread of the inlet coupling bushing, turning it by hand. Then insert the wrench into the opening of the inlet coupling and turn until the flange is drawn up snugly against the baseboard, stopping with the cover hinge at the top.

Use Good Lead or Pipe-Joint Paste.

In the installation of piping for vacuum cleaning, always apply lead or pipe-joint paste to the male threads of pipe and fittings. If applied in this way when the threads are made up, all surplus lead or paste will be forced to the outside of the fittings and pipe, leaving the interior free from such substances.

Never apply lead or paste to female threads.

Typical riser, concealed in partition, one inlet coupling to be located in baseboard in each story.

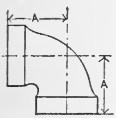
Section of Cleaner-Main.

When it is necessary to drop a pipe for an inlet coupling located below the cleaner-main, always make the connection from the side of the cleaner-main, and never from the bottom—as bottom connection would fill with dirt.

Drainage Fittings, Cast Iron, Screwed for Wrought Iron Pipe.

These fittings are made with a shoulder, and are the same size inside diameter as pipe.

The pipe screws in up to the shoulder, making a continuous passage, leaving no pockets for the solid matter to lodge in, thus preventing choking up of the pipe.



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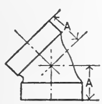

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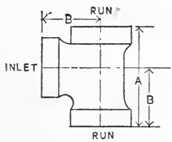

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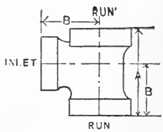

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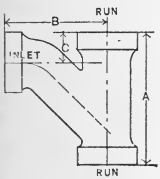

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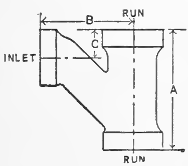

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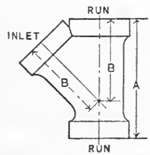

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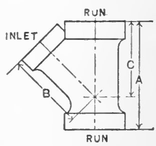

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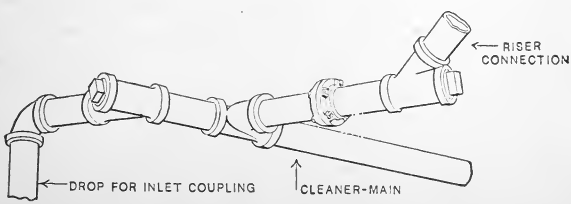
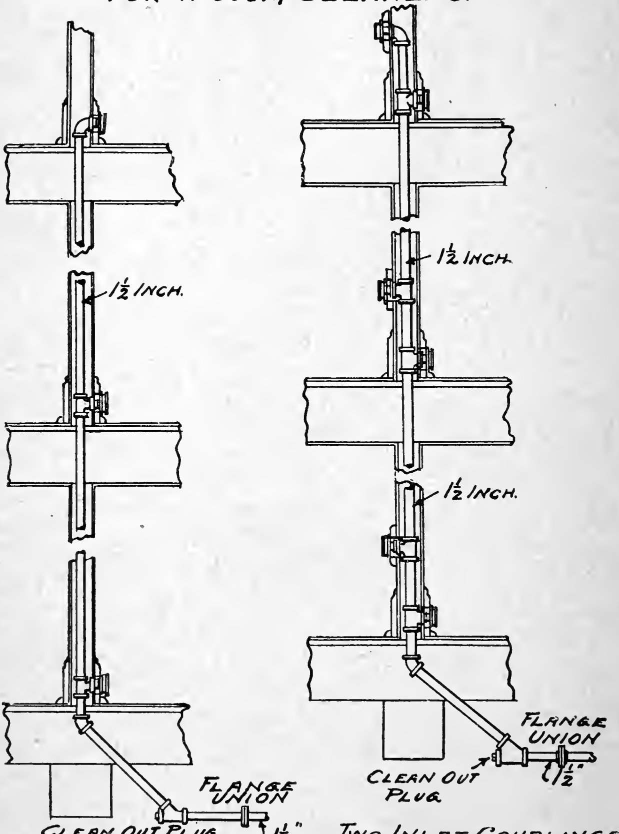


TYPICAL RISER PLANS FOR VACUUM CLEANERS.



ONE INLET COUPLING FOR EACH FLOOR.

TWO INLET COUPLINGS FOR EACH FLOOR

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SUPPLEMENT

to

Eleventh Edition

of

JOHNSON'S NEW HANDY MANUAL

on

PLUMBING

Index to Supplement on following page

INDEX TO SUPPLEMENT ONLY

(For General Index see Page 231)

PARTS

Sketches No. 1 to No. 11 on pages 187 to 196 and on several other pages in this book show different kinds of traps in more or less common use. The trap is very vital, as on the proper operation of the trap depends the success of the plumbing system from a sanitary standpoint. A trap is a vessel filled with water, and the purpose is to prevent the passing of gases and odors from sewer or cesspool and from the plumbing system itself, into the house. In order to protect the house from such danger a trap is required not only under each plumbing fixture, but also on each floor drain, cellar drain, rain leader, etc.

Traps used in plumbing may be said to be based on one or the other of two fundamental styles. These are shown by sketch No. 10, page 195, and are the S. trap and drum trap. The S. trap is of various types, such as full S. trap, ¾ S. trap, and ½ S. trap. By many the S. trap is considered the best style, as it is self-scouring and less liable to become foul. One argument against the S. trap is that it can easily lose its seal, by siphonage, resulting in opening a direct communication between sewer and the house. The characters of the S. and drum traps are exactly opposite. Where one is weak the other is strong. The drum trap holds a large body of water, a large part of which is inactive. Therefore this trap will not be as free from filth as the S. trap. The drum trap is less liable to siphonage. A 4-inch drum trap is found by test to be practically non-siphonable.

There are places where either style will be better than the other. For instance, when vented and used in connection with lavatories, sinks, water closets, main trap, etc., the S. trap is a better and more convenient trap to use. Having the advantage of being self-cleaning, its size and the size of connecting pipes does away almost entirely with the danger of siphonage. Often it will be advantageous to have a delivery from the trap as rapid as possible. A delivery from an S. trap in such cases answers the purpose much better than delivery from a drum trap. The drum trap is well adapted to

use beneath floors, as for bath tub work. Waste pipe for bath tubs have as a rule very little fall, especially when the trap is some distance away. Under such condition more pitch can be had by the use of a drum trap and, having a great depth of seal, it is very well fitted for fixtures not often in use, for with shallow seal evaporation soon breaks it. It is considered not a good practice, still it often happens that two or more fixtures enter into one trap, as bath tubs and lavatories or sinks and laundry tubs. In such a case a drum trap is best, as the drum allows several pipes to enter at the bottom and a larger size pipe from the top forms the outlet.

From these traps many variations have been made. One kind consists of a ball resting against a seat, the ball being displaced when water enters the trap and re-seats itself after waste stops running, and the seal, called mechanical seal, depends on the seating of the ball for additional protection, as the traps have only ordinary water seal. When new, such traps may do good work but they soon become foul when they fail not only to perform their work but also become an obstruction around which substances may collect and form a complete stoppage.

Besides the ball traps there are many other mechanical traps which I deem it not necessary to mention. Many ordinances forbid the use of mechanical traps. The nearest approach to a perfect trap is found in the modified forms of the drum trap, of which there are many good makes.

Siphonage of Traps

The term "seal trap" is used very often and is a matter of great importance. Figure No. 1, below, illustrates this. At normal condition the water stands at "A." Should it fall below "B," the trap becomes useless, as it no longer prevents the entrance of sewer gas. The water between levels "A" and "B" is called the seal of the trap. This seal may be destroyed or broken in many ways. It may be destroyed by siphonage, by capillary action, by evaporation, back-pressure, momentum, and by gust of wind. The destruction by siphonage is a

matter of great importance. Capillary attraction is the power possessed by liquids of rising through very fine tubes to a higher level than that of the liquid in which the tubes dip. It is this action which causes a sponge to fill with water. Its way of breaking the seal in a trap may be shown in figure 2, which represents a string or collection of lint or other substances dipping down in to the seal of the trap and terminating in the outlet. Capillary action will make the water in the trap follow up through this collection and drop over into the outlet. This is a serious danger in cases of fixtures that are seldom used, whose trap seal therefore is seldom renewed. Capillary action by withdrawing the water from the seal a drop at a time, may after a while destroy it entirely, and it may do so in an extremely short time.

In breaking of seal by evaporation the danger is far less in unvented traps than in vented traps, due to the fact that the vent brings in a supply of air which increases the rate of evaporation. Back pressure upon a trap seal is a pressure generated in the sewer and acts upon the sewer side of the trap. A poorly ventilated sewer is liable to produce such a pressure caused by expansion or sudden rise in temperature, which might be caused by steam or hot water entering the sewer as well as many other causes.

The breaking of trap seal by momentum is caused by the rushing out of waste from the trap with such a force that a part of the whole of the seal is carried with it. The breaking of a trap seal by a gust of wind is of rare occurrence, but it sometimes happens. The trap of a water closet, located on the top floor, for instance, and connected to a soil pipe extending through the roof, may lose a few drops of its seal from time to time, owing to gusts of wind passing over the opening of the pipe. The trap seal is broken more frequently by siphonage than by any other cause, and this is the greatest obstacle and prevents the attainment of a perfect trap.

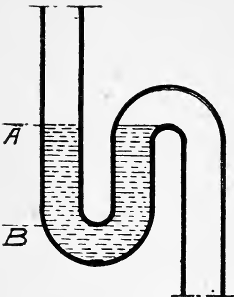


Fig. 1
Trap Seal

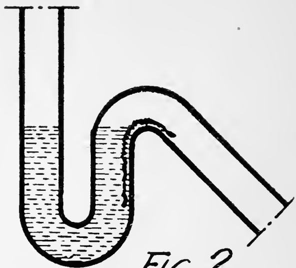


Fig. 2.
Seal Broken By
Capillary Action

Siphonage Explained

I will try to explain and show the cause of siphonage in as few words as possible and at the same time make it clear to the reader. To explain the siphon action on traps we must study the simple siphon, and for this purpose will refer to Figure 3. The siphon is resorted to for the object to transfer a liquid from a higher to a lower level. The siphon of a bent tube with one leg longer than the other. The short end extends into the liquid to be removed, while through the long arm flows the liquid to the lower level. To attain the siphonic action the air must first be expelled from the long leg,—a vacuum must be created. The moment that a vacuum is formed in the long arm the atmospheric pressure acting upon the surface of the liquid no longer has any force to counter balance it, and the liquid is forced up the short arm and over the bend of the siphon passes into the long leg, or discharge leg. If not, by some means, broken, the siphonic action will continue until the liquid falls to a point below the end of the short arm. The pressure of the atmosphere is very close to 15 lbs., —14.7 lbs. to be exact,—per square inch. Therefore, with a very good vacuum siphonic action is very strong and rapid.

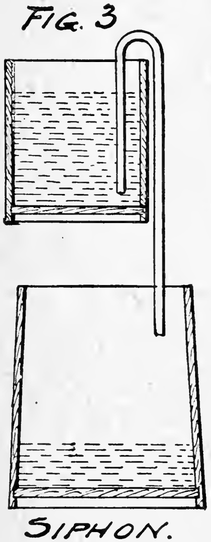
One leg of the siphon must be longer than the

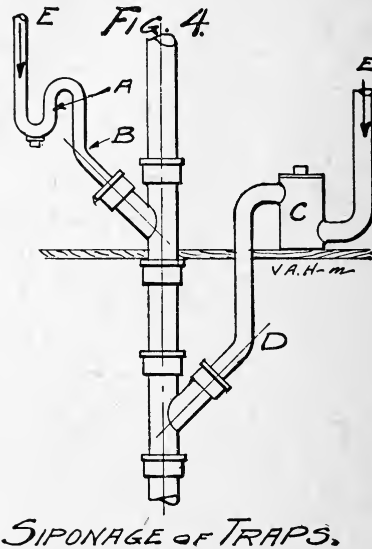
other so that the heavier column of liquid in the long arm will exert a pulling force or suction on the liquid in the short leg. If it was not for the difference in he length of the legs of the siphon, the liquid in either leg would fall back on account of the weight of the liquid, and the siphonic action would be broken. The greater the difference in the length of the legs is the stronger will be the action of the siphon, unless the long arm is made so long that advantage gained is overcome by friction created.

Siphoning may be destroyed by admitting air at or near the bend, or crown; which, as will be shown in the next chapter under the head of "VENTING," is made use of in a plumbing system to prevent siphonage of traps. Being one of the greatest obstacles that have to be overcome in a plumbing system, siphonage is also a great aid in plumbing construction. The action of many first class plumbing fixtures, valves and other devices depends in many instances on the siphonage principle. In Figure 4 it will be seen how the connection of both S. and drum traps presents the same conditions as may be noticed in the siphon shown in Figure 3. The leg "A" of the S. trap is the short leg of the siphon and "B" is the long one. The difference here between the lengths of the legs is often quite great. A vertical column of water in the trap of the size of the waste pipe is in a drum trap the short leg of the siphon and "D" is the long leg. Atmospheric pressure in each case is acting as shown by arrow "E." We have only to produce a siphonage of each trap, which is made by creating a vacuum or partial vacuum in the long arm.

There are many opportunities in an unvented plumbing system for the formation of a vacuum. In Figure 4 it may be formed by the passage of a great volume of waste past the entrance of the branches on the two waste fittings on the soil pipe line. The effect and causes of siphonage in a plumbing system may be studied from Figure 5, which is a system usually installed years ago, with no soil pipe venting through the roof and without trap ventilation of any kind. In such a system the most favorable condition to siphonage is that the

vertical line of soil pipe ends at the top fixture instead of continuing through the roof with an open end.





Should a large body of water enter into the vertical pipe from several fixtures at the same time, even though the volume is not sufficient to fill the pipe entirely, owing to its spiral motion in falling the effect may be nearly the same. The air is forced ahead of the falling column of water, and a partial vacuum is formed in its rear, and the effect may be felt in more or less degree on every trap in the building. Each trap on the top floor may be siphoned; even the 4-inch water closet may be affected by this action. In a big building where there is a large amount of plumbing of the old time style, the siphonage of traps would be even more certain to occur than as shown in Figure 5.

If a heavy body of waste water passes down a vertical soil pipe from, say, the three floors above, then as this column enters the horizontal line it is, of course, retarded. The waste then backs up

and fills the pipe at this point, and, in attempting to pass out, produces a partial vacuum, which is sure to be felt by the fixtures in the basement.

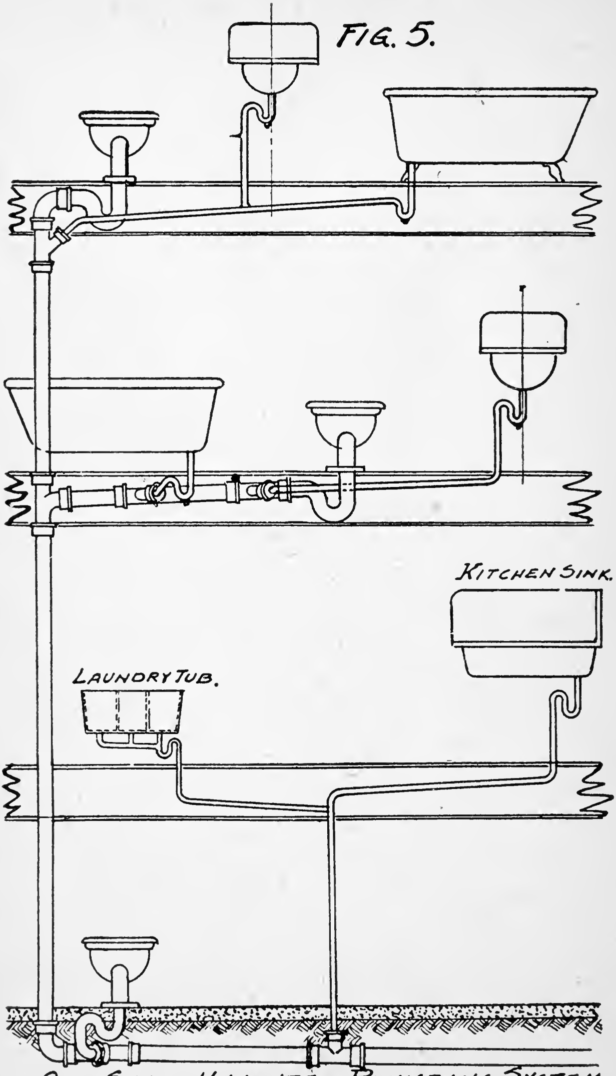
In Figure 5 it will be noticed that the waste from upper bath and lavatory and from all fixtures on the second floor has little pitch and is of considerable length, and is most favorable for trap siphonage. The very small fall allows the waste to set back and fill the pipe, and, as is mentioned above, in attempting to pass the waste partially exhausts the air in the pipe, and the siphonage, full or partial, of the trap is the result.

Often the trap is affected only slightly by the siphonic action, only a few drops of the seal being lost at a time. In a fixture that is not in constant use. it is only a matter of time when enough seal will be lost to break the seal. Even though the siphonic influence may not be great in case of a certain trap, it still has its danger. Stoppage in waste outlets may have a result similar to that mentioned about fixtures having long wastes without proper pitch. Much old work has been put in such as that of kitchen sink and laundry tub Figure 5, and has given abundant opportunities for siphon trouble. A heavy flow of waste through the horizontal soil line might siphon either sink or laundry tub trap. A heavy flow from either fixture might siphon the other; and either fixture might siphon its own trap. Old style plumbing was susceptible in many ways to trap siphonage, causing sewer gas in rooms, which in many cases had fatal results.

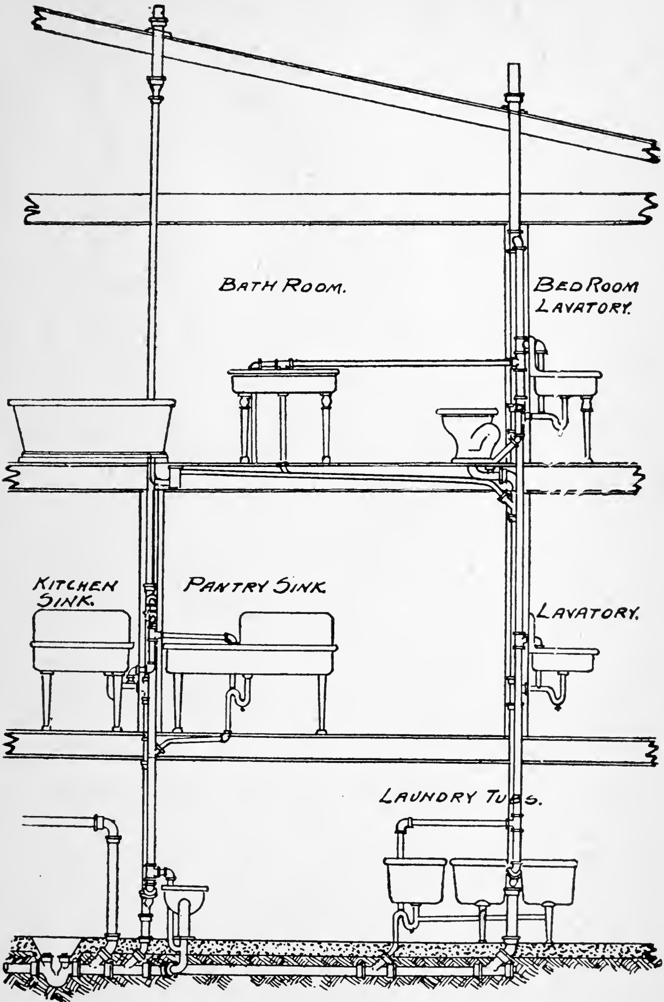
Other defects can also be found in old style plumbing, such as the use of tee fittings on the drainage system, the entrance of waste into the heels of the bend, etc.

Figure 6 shows a complete modern system of plumbing, with its main line of vents and also branch vents. The great advance made in plumbing installation can be readily seen by comparing Figure 5 with Figure 6.

FIG. 5.



OLD STYLE UNVENTED PLUMBING SYSTEM
TRAPS LIABLE TO SIPHONAGE.



PLUMBING FOR RESIDENCE.

VENTING

The principle of venting has been known for a long time, but it is only lately that venting has been applied to plumbing to overcome siphonage. Now, venting is second only in importance to the trap. Venting may be classed in two forms: soil or waste vents and trap vents. There are also two other forms of venting, viz, the local vent and the fresh air inlet, but they do not belong to our present subject.

The soil or waste vent is a continuation of vertical soil and waste lines above the highest fixtures and through the roof, terminating with an open end with an increaser. By the installation of vents all trouble from back pressure in connection with trap seals is prevented, the vent relieving all pressure that may come from the sewer.

The importance of the vent can be understood when comparing system shown in Figure 5 with the system in Figure 6, supplied with soil and waste vents. Besides relieving the system of back pressure it purifies and lengthens its life, and in addition is often an aid in installing the trap vents. Soil and waste bents should be carried at least 18" to 24" above the roof. and above any opening in the roof or windows in buildings near by.

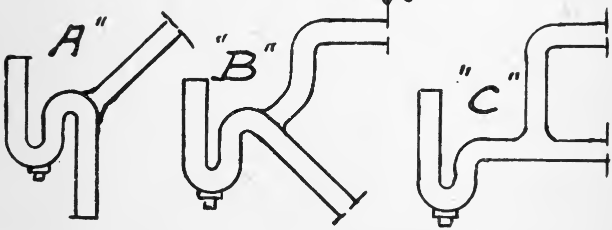
There is a danger to vents, especially in cold climates. that should receive attention. The vapor from the stacks is likely in cold weather to form a mass of frost in and around the vent opening, and if the pipes are small, close up the pipe altogether. No pipe less than 4 inches should pass through the roof. All pipes of smaller size should have an increaser so that the part extending through the roof is not less than 4 inches. Vent covers or wire cages should never be placed at the top of the vent pipes, as they contract the opening and allow frost to be formed, on account of the decreased opening.

Venting of traps is, as said before, very important. I have mentioned in preceding pages under the head of "SIPHONAGE EXPLAINED," that the admission of air at the crown of the trap will destroy the siphonic action; as the admission of air destroys the vacuum and without a vacuum

there can be no siphonic action. A trap vent is a pipe which carries air to the crown of the trap and prevents the forming of a vacuum, making the siphonage of the trap impossible. Trap vents must, of course, be connected with the outside atmosphere. This is done by connecting the trap vents of several fixtures to a main vent, which passes either through the roof or connects to a soil or waste vent above the highest fixture. A trap vent, or back vent, as it is also called, should always be connected to the trap at or near the crown and on the sewer side of the trap. The vent should always enter the main line at a point higher than the fixture. If connected below the fixture, the result would be that in the event of stoppage of the outlet from the trap the waste would pass through the vent into the drainage and thus continue until the vent in turn was stopped.

While theoretically the proper point for connecting the vent is at the crown of the trap, there is an objection to this, because it brings the fresh air supply directly upon the seal of the trap and greatly increases the rate of evaporation. Connect the vent in such a way that this danger will be avoided. Figure 7 illustrates how this is done. On account of its construction this precaution is not required for drum traps.

FIG. 7.



VENTING OF "S" TRAPS.

Another important point in connection of vent traps is to make connection in such a way as to

eliminate, as far as possible. the chances of vent being stopped up by lint, grease and sediment. In Figure 7 the danger from causes of this kind is present, but to a much less extent in the half S trap, marked "C" on illustration. In this trap the evaporation will also be less than in the other traps, as the vent connection is of greater distance from the seal than in the other style of traps. A majority of vents become almost, if not altogether, closed with grease, lint, etc., and in that condition are useless. Manufacturers have tried to overcome this danger, but not as yet successfully. There are ordinances which call for a clean-out on each vent trap, but this does not solve the difficulty, for the place where the trouble is hidden from view and the exact place is never known. Owners or tenants know little or nothing about this matter and cannot be expected to clear the vents. Therefore, great efforts have been made in getting a non-siphoning trap, as such a device would not require a vent and would eliminate the venting trouble. Some cities have adopted certain "non-siphonable traps" and are taking chances with these traps rather than the ordinary vented trap with its danger of being closed up.

Now, a few words about the **drum trap.** Most drum traps are installed as shown in Figure 8. The fault to find with this style is that if the trap screw is not tight there will be a communication with the drainage or sewer system and the house. A condition like this would also occur when the cover was removed for the purpose of cleaning the trap. This can be avoided by a connection as shown in Figure 9. But there is an objection to find in this style, as there is a greater length of pipe in which waste might stand and cause the fouling of the outlet; but Figure 9 is a very satisfactory way of connecting. Connected as shown in Figure 10 will also prevent the gas from escaping when the cover is off or there is a leaky gasket; but as the outlet pipe projects into the trap it is an obstruction in the trap to which filth is liable to collect and likely to stop up the trap. The vent part is very good and is of less danger of stopping-up than in a good many other connections. This is also the case of connections as shown

in Figure 12. The method of taking the vent from the trap screw as shown in Figure 11 is common but is not very good. Connection as shown in Figure 12 is good in some respects as any leakage will be shown at once, but it is impossible to prevent the escape of gas when the cover is taken off.

The manner of supplying air to a trap vent varies. If there are no fixtures above, vent can be connected to the waste or soil stacks at any point below the roof, or it can be carried directly through the roof or connected to the main vent, as shown in Figures 8 and 12. One objection to entering the trap vent directly into soil or waste stacks, as can be done when there are no fixtures above, is this: unless fixtures are on the top floor, other fixtures may be at a future time located above them. To carry a trap vent directly makes an extra roof connection and adds an extra expense; besides the pipe is further away from main system, the air is colder, and the circulation of air less satisfactory. A very good way is to connect the trap vent with the main line vent. When running the trap vents, as well as main vents, they should always be made to pitch upward at all points. A great deal of condensation and scale is forming in vent pipes and without a pitch to the pipe these cannot go back to the trap, where they will flow away through the waste. Trap vent should, as a rule, be of the same size as the trap. An exception to this is the vent from a water closet. Although a water closet waste is 4 inches, a 2-inch vent is enough. For a properly installed water closet the 2-inch vent is taken off from the top of the 4-inch horizontal part of the lead bend, extended above the closet and connected to the main vent. A very poor practice is to connect the vent to the vertical arm of the 4-inch bend, as paper, etc., is likely to collect about the entrance and in time close it.

An old fashioned way was to connect the vent to the horn of the closet, as found in wash-down closets. It is now forbidden in nearly all ordinances. The objection to this form is that a blow or settlement of the fixture may break the horn, as the vent pipe is rigid.

Water closets are not so easy to siphon, as it

more difficult to create a vacuum in a 4-inch pipe than it is in a smaller one. Therefore it is not necessary to vent it under certain conditions, as when it is located close to a stack on the top floor.

Vents from a number of fixtures can be connected into one line with this line connected to the main vent, and is in many cases preferable to running independent trap vents to the main. If so installed, several vents enter into the branch that leads to the main vent. Therefore the size of the branch vent shall be increased. See Figure 13.

With a small number of fixtures such as found in the ordinary bath room the 2-inch vent from the water closet is large enough to receive vents from other fixtures.

The main branch vent pipe should always be placed and enter the vertical main vent above the top of the highest fixture to prevent it from acting as a waste or soil, should there be a stoppage in any part of the waste. When located at a distance of 8 feet or more from the main vent to which the trap vent is to be connected, vent should be carried independently through the roof or the main at a point above all fixtures. For long lines of vent the size should be increased one size, as, in long pipes, due to the friction, the delivery of fresh air is not as rapid as in a short run.

On pages 95 to 102, inclusive, is an article with illustrations Nos. 43, 44, 45 and 46, which give a description of the installation of up to date sanitary plumbing. Another article, on page 145, under the heading "Combination Vent and Drainage Connections," with illustrations on pages 146, 147 and 148, describes and shows the so-called F & W combination fittings.

FIG. 8.

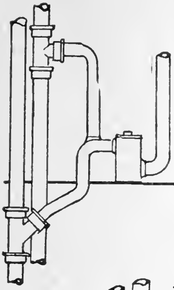


FIG. 9.

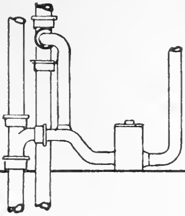


FIG. 10.

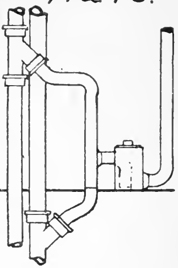


FIG. 11.

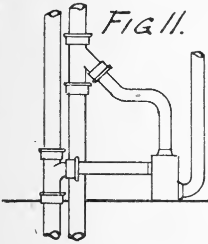
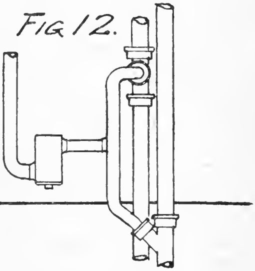
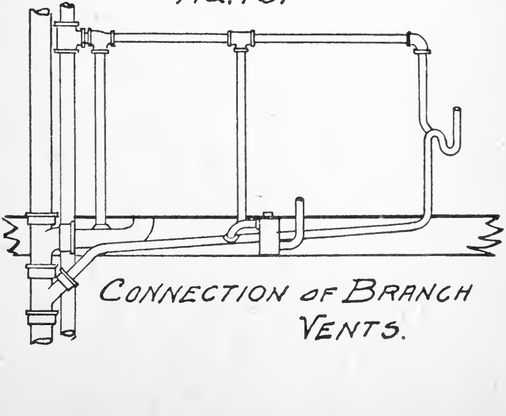


FIG. 12.



WASTE AND VENT CONNECTIONS FOR DRUM TRAPS.

FIG. 13.



CONNECTION OF BRANCH VENTS.

Continuous Venting

There is a system known as "continuous venting" which, it can be said, is free from the danger of stoppage; and, as known, the stoppage of a vent is more dangerous than that of a waste, as the stoppage of a waste makes itself known by backing up into the fixtures, while stopping-up of a vent is not known unless the vent is taken apart. It has been mentioned before,—in the article on traps,—that the accumulation of grease, etc., around the vent opening may close it up and cause siphonage in the trap. Mechanical devices have been tried to do away with this danger, but without success. Even the placing of a clean-out plug on the trap vent has been tried, but has not solved the trouble. The continuous vent seems to be the best solution.

There may be cases where it is hard to employ this method, but as a rule it can be done. Sometimes this is called "venting in rough," and from illustrations, sketches No. 11, 13, 14, 15 and 16, pages 196 to 201 inclusive, also on page 90, the principle can be seen. It consists mainly in using T-Y fittings in such a way that vent can be taken off at the top and waste from the bottom. For this style of installation only a half "S" trap can be used. The chances of closing the vent opening in this style are very much less than in the common style so often used. The opening is further from the trap; therefore more free from splashing of water as it enters the trap. Evaporation is less, and the use of T-Y fittings makes the accumulation of grease and other matters less liable. In this style of venting no parts, except the trap, need to be exposed.

The cost of installation of this system, both in materials and labor, is much less than for the other system, and the larger the work is the more is the percentage of savings.

For a line of a number of fixtures, as shown in Figure 14, this style is well adapted and is very much used, as it allows both the horizontal main waste and main vent to be run back of the partition. Vent is also taken off far from the trap,

so the evaporation is less than in ordinary work and the danger of failure of trap, due to evaporation, is much less.

Figure 15 is a modified style of continuous venting called "circuit venting" and is used very much for batteries of water closets in hotels, offices and public buildings, where large toilet rooms are located above each other on several floors. The illustration shows the line on only one floor as the installation on all the floors is similar. The principle consists in locating at either end of a battery of water closets a vertical, one for soil and waste and another for main vent. Both vertical stacks are carried through the roof, giving an abundant air circulation to the fixtures. Great savings in materials and labor are also made, as in independent vent method a vent has to be taken off from each lead bend.

Should there be other fixtures besides the water closets connected to the rorizontal soil line, the vent from such fixtures should be run the ordinary way and connected to the vent stack.

Continuous venting is the nearest to perfect plumbing, and when this becomes known it will be universally employed.

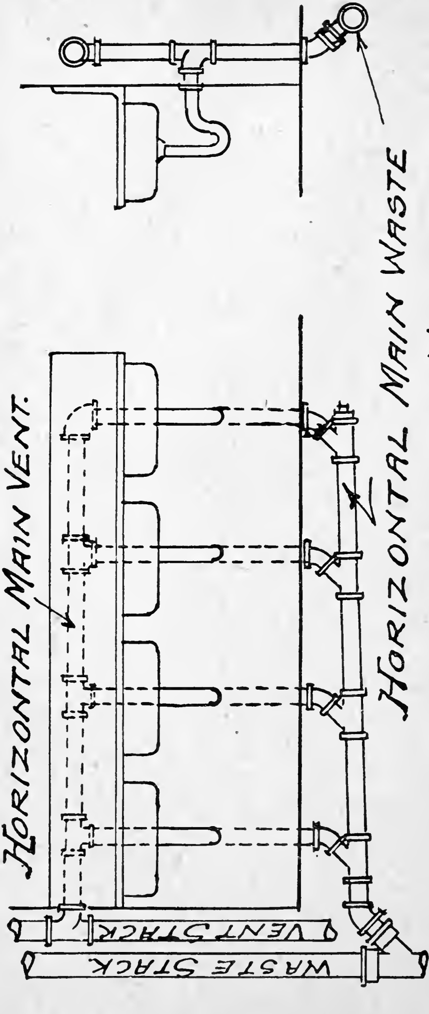


FIG. 14.

—CONTINUOUS VENTING— FOR —LAVATORY FIXTURES.—

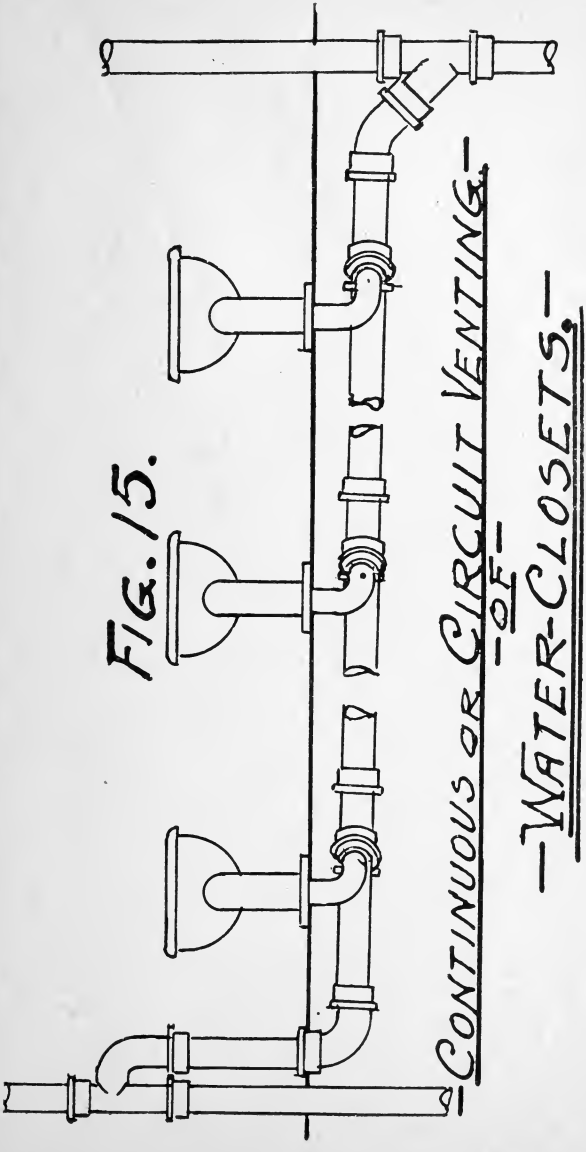
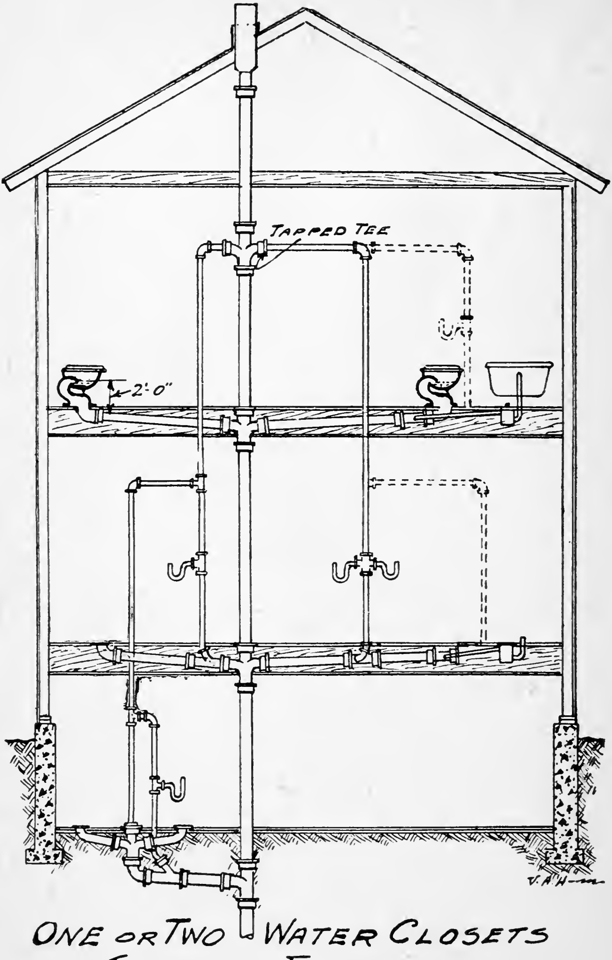


FIG. 15.

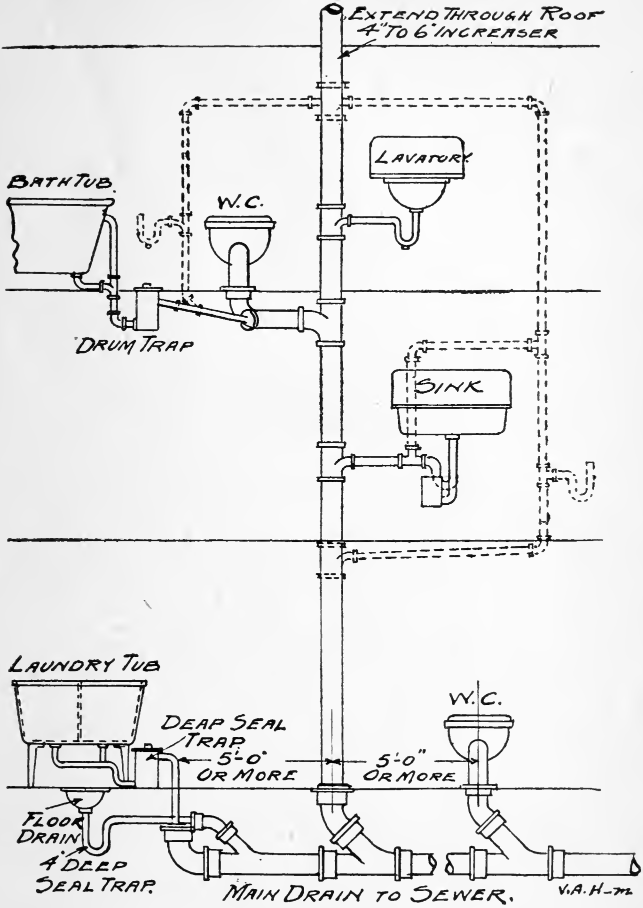
CONTINUOUS OR CIRCUIT VENTING —OF— WATER-CLOSETS.

Much other useful reading matter and several illustrations on the subject of venting and wastes will be found under the heading, "Installation of Sanitary Plumbing," pages 95 to 109 inclusive. I advise everybody to examine the illustrations and read the explanations.

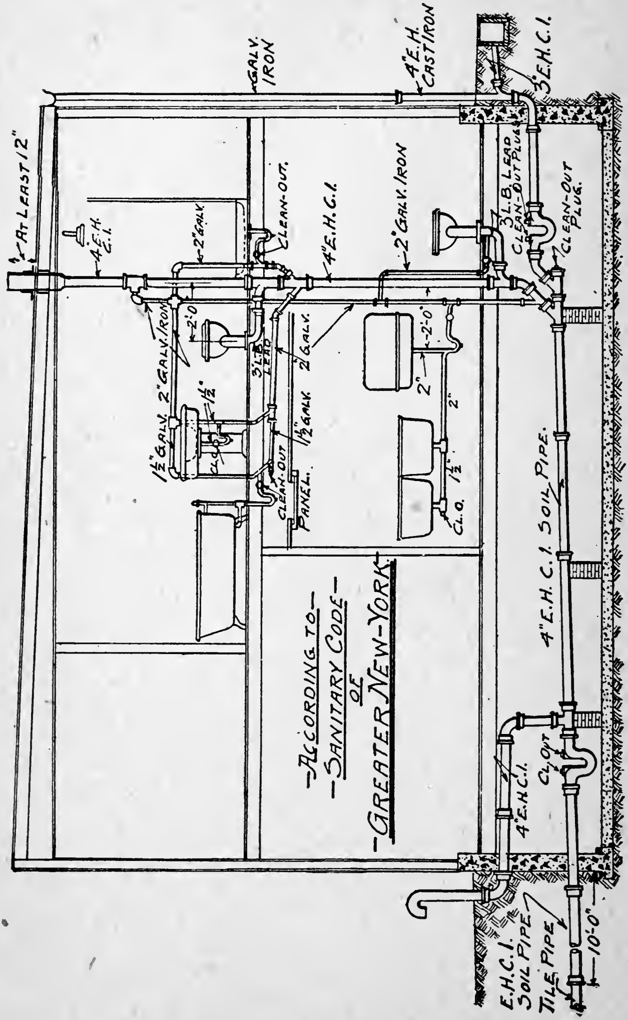


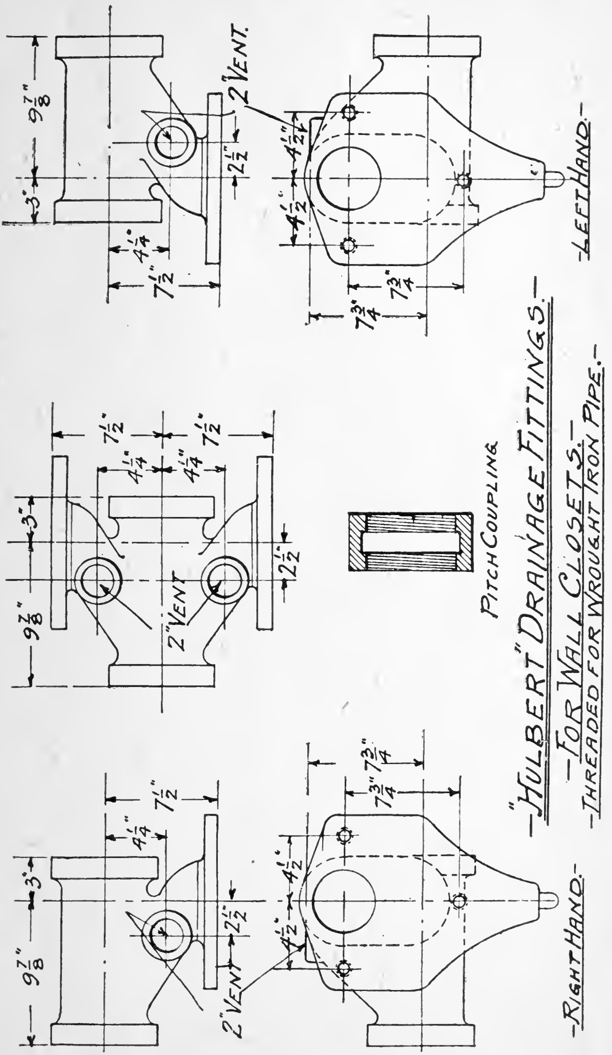
ONE OR TWO WATER CLOSETS
OR SIMILAR FIXTURES

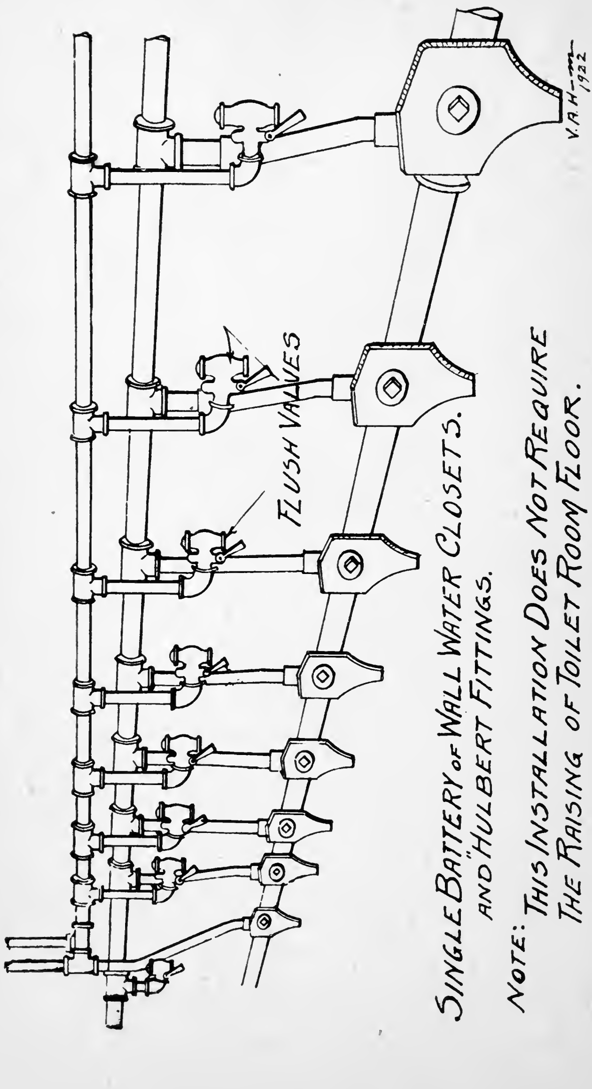
SKETCH No. 28.


EXTEND THROUGH ROOF
4" TO 6" INCREASER
LAVATORY
BATH TUB
W.C.
DRUM TRAP
SINK
LAUNDRY TUB
W.C.
DEAP SEAL TRAP
5'-0" OR MORE
5'-0" OR MORE
FLOOR DRAIN
4" DEEP SEAL TRAP
MAIN DRAIN TO SEWER.
V.A.H-m

SKETCH No 29.

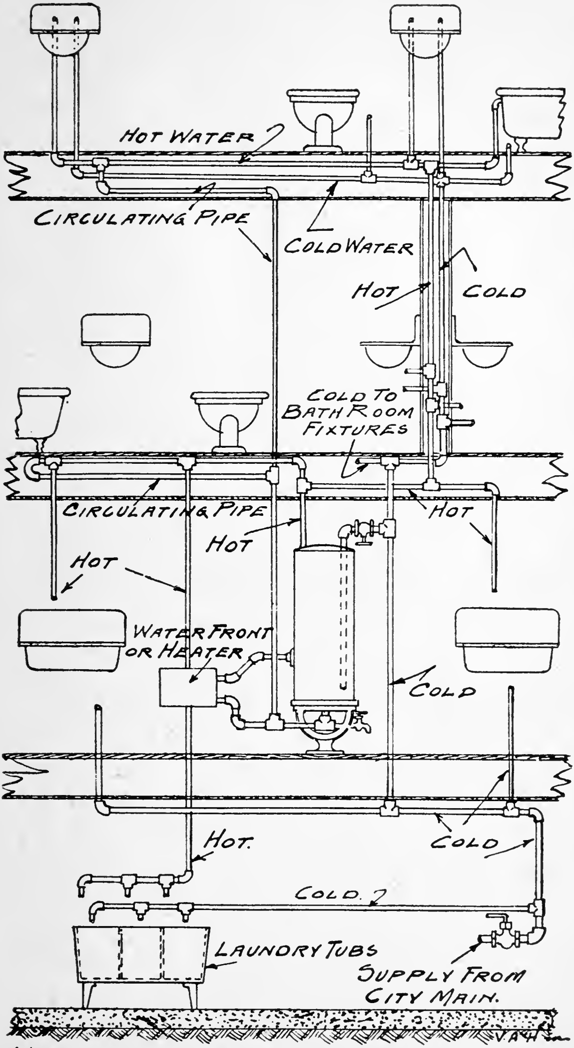

According to
Sanitary Code
of
Greater New-York
At least 12"
Galv. Iron
4" E.H. Cast Iron
3" E.H.C.I.
4" E.H. C.I.
2" Galv.
Clean-out
4" E.H.C.I.
2" Galv. Iron
3 L.B. Lead
Clean-out Plug
2" Galv. Iron
3 L.B. Lead
2" Galv.
1½" Galv.
1½" Galv.
Clean-out
Panel
2'-0"
2"
Cl.O.
4" E.H.C.I. Soil Pipe
4" E.H.C.I.
Cl. Out
E.H.C.I. Soil Pipe
Tile Pipe
10'-0"


-"HULBERT" DRAINAGE FITTINGS.-
-FOR WALL CLOSETS.-
-THREADED FOR WROUGHT IRON PIPE.-
-LEFT HAND.-
-RIGHT HAND.-
PITCH COUPLING
2" VENT.
2" VENT
2" VENT
3"
9 7/8"
4 1/4"
7 1/2"
2 1/2"
4 1/2"
7 3/4"

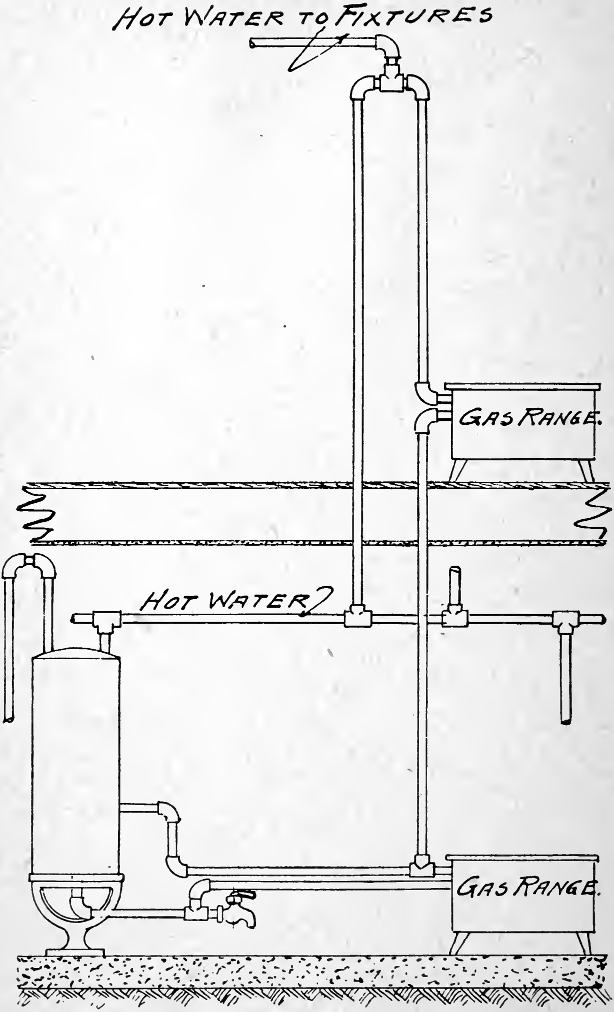


SINGLE BATTERY OF WALL WATER CLOSETS.
AND "HULBERT FITTINGS.

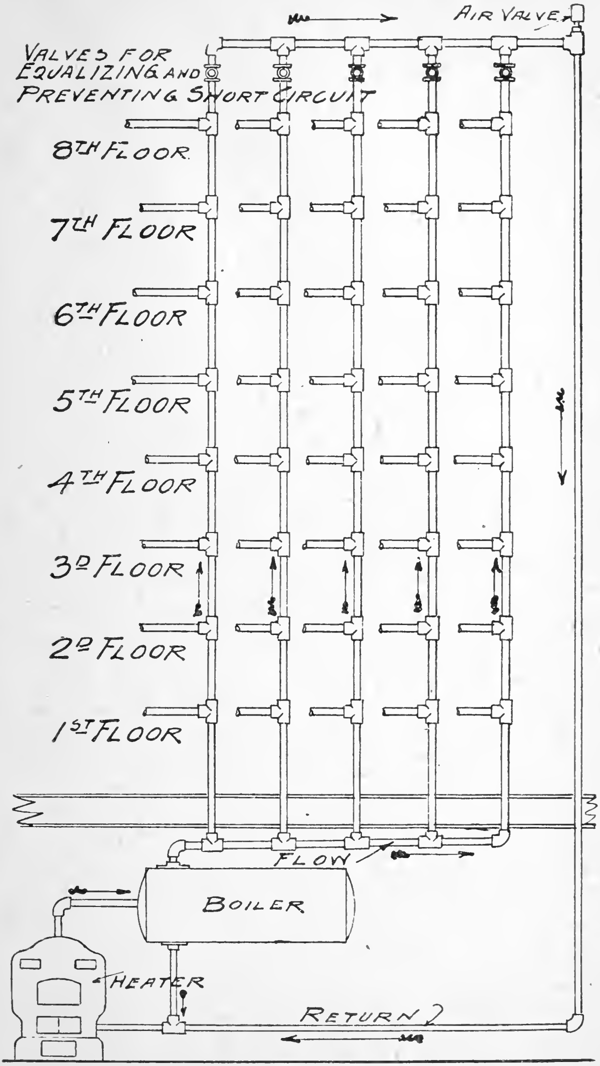
NOTE: THIS INSTALLATION DOES NOT REQUIRE
THE RAISING OF TOILET ROOM FLOOR.



HOT AND COLD WATER INSTALLATION. WITH HOT WATER CIRCULATION. SUITABLE FOR A RESIDENCE.



BOILER HEATED BY RANGE — EITHER ON SAME FLOOR OR FLOOR ABOVE.



HOT WATER SUPPLY FOR APARTMENT AND OFFICE BUILDINGS.

The Coatsbill Heat Exchanger

A patent has been granted for a new type of hot water exchanger which can be attached to the heating boiler of the home. This exchanger has several very interesting features which are of great importance to the plumber, architect and heating engineer who desire to give their clients the most efficient heating system for the heating of the home. It includes a good supply of hot water for domestic use in the kitchen, bathroom, and for any household use where a constant supply of hot water is needed night or day during the heating season, with a large saving in your fuel consumption.

Owing to one of the many good features of the exchanger, the ejector nozzle,—a part of the exchanger,—creates a partial vacuum on the return line of the heating system that improves the circulation to such an extent that the radiators are heated more quickly, thereby closing the damper on the boiler which checks the fires and saves coal. In some installations, as high as 20 per cent less coal is used to do the same heating, plus an abundance of hot water for domestic purposes. Its use eliminates the gas or any other heater during the heating season, and by not using gas for heating quitt a saving is made.

The installation of the Coatsbill Exchanger can be followed on drawing No. 1. The first connection is made at "A," which should be two inches below the water line of the boiler. "B" connection is to be used only on hot water systems. "C" connection is to be used with steam systems. "D" connection is the return steam line. "E" connection is a sediment settling chamber at the bottom of the heating elements. "F" is the hot water storage tank which can be located either in basement or kitchen.

There is nothing unusual about the installation of the Coatsbill Exchanger, and it can be attached to the heating boiler at a small cost on new installations. All of the leading boiler manufacturers are now tapping all of their boilers for "A" connection.

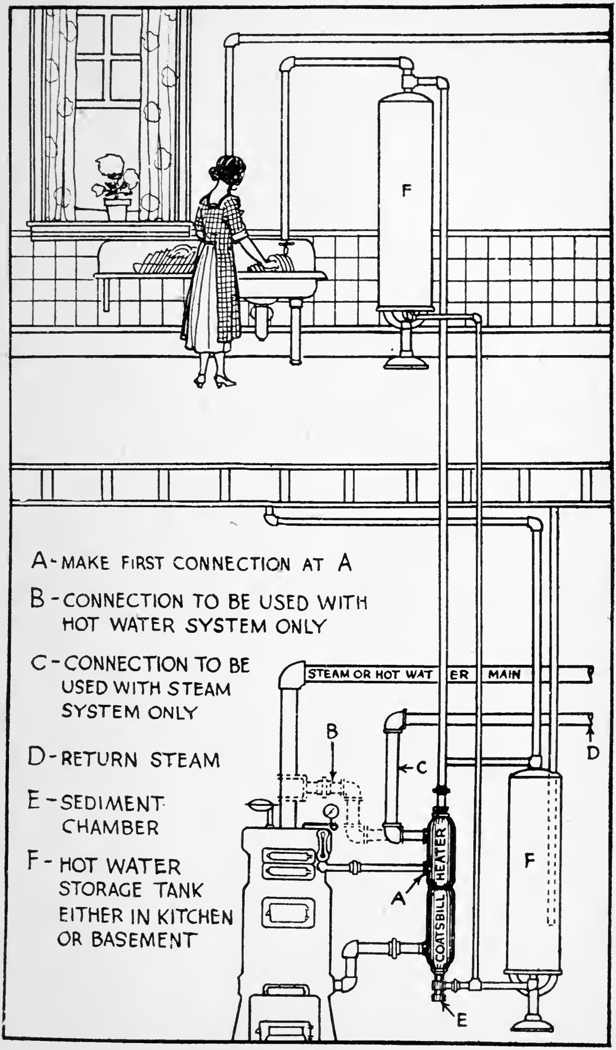
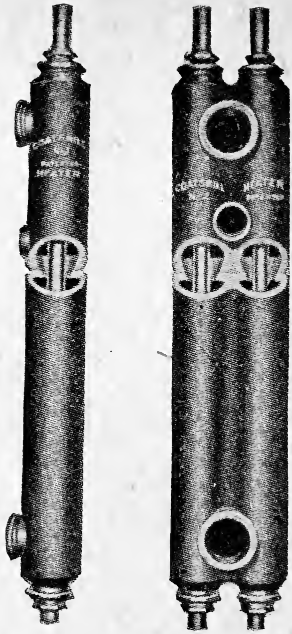


ILLUSTRATION OF COATSBILL HEAT EXCHANGER



The operation of the Coatsbill Exchanger can be traced on drawing No. 1. When the fire in the heating boiler is started, the hot water arises to the top, passing through "A" connection. The water is colder at the bottom of heater, thereby setting up a circulation through the Exchanger back to the boiler. By the time water is up to boiling point in the boiler, the circulation is so rapid through the ejector nozzle that it causes a partial vacuum on the return line "C," bringing the return water and vapor back to the boiler so much more quickly. On heating system where the lines are trapped and have considerable water hammer, the Coatsbill eliminates this entirely and shows on every installation a saving in coal consumption, with greater heating efficiency.

The Coatsbill Exchanger is built very strong for reliable, safe and economical operation. It will

last a lifetime. There is nothing to get out of order, as the expansion of the heating elements is taken care of by the slip joint at the top of the exchanger. There are no joints inside of the exchanger to leak, which is so prominent in other types of heaters. It is installed in the return line, so it does not take much more room than the pipe itself. The body is cased in one piece, so there are no troublesome gaskets to leak. It is also neat in appearance. The heating elements are of standard weight brass pipe which will stand a very high bursting pressure. It is placed in a vertical position, so there is no possible chance of clogging. The Exchanger is guaranteed against all defects in workmanship and material. Number one Exchanger will exchange 38 gallons of water from 60° to 160° in one hour's time. The Coatsbill Exchanger is built in sections so that a larger amount of hot water can be made for large apartment houses, hotels and public garages by placing the sections together in multiples, like a radiator.

Sanitary Water Supply and Analysis

Melville Dreyfuss

In writing on the subject of water supply and analysis, it is difficult to cover such a large field in a few pages. Therefore, the ideas on water treatment given here must not be considered by any means a complete treatise on the subject, but rather a sketch of those phases which are of most interest to the layman.

Water is tested in the laboratory both chemically and bacteriologically. The chemical tests give the analyist an idea of the past history of the water. Such tests as those for nitrates, nitrites, free and abuminous ammonia, show that sewage and other forms of contamination which at some previous period had polluted the water have been decomposed by chemical action into new forms, and must be treated accordingly.

The bacteriological examination for the presence of Bacillus Coli is the most important test of the

entire analysis. Bacillus Coli is an organism found in the human and animal intestine. Therefore, it is plainly seen that whenever water is found which carries Bacillus Coli, that water must be polluted with human or animal excreta. The organism in itself is not dangerous but it is significant as indicatory of the probable presence of disease germs, especially the germs of typhoid fever. In view of the above facts, the presence of Bacillus Coli in large numbers in a small sample is a direct indication of RECENT sewage polution and an investigation should be made at once, resulting either in the purifying of the water or shutting off the supply.

The best means of counteracting contamination in water is by means of chlorine. Chlorine is a chemical element which when introduced into the water acts as a disinfectant without giving it a disagreeable taste, or a harmful effect. This system of purification is in use in the City of Chicago where for several years the water has been kept almost entirely free from disease producing organisms. The chlorine is put into the water at the pumping station. With every million parts of water a definite amount of chlorine is released into the water by a machine attached to the pumps. This amount is generally 2 to 3 gallons to one million gallon of water. This, along with sanitary restrictions protecting the water supply, keeps Chicago water in the best of condition.

In conclusion, a few words on the way a sample should be received at the laboratory. It is of course necessary to use sterile glass containers free from dirt and other foreign substances. For bacteriological samples, glass stoppered bottles containing about ½ pint, are best. In reporting on a sample the analyst depends as much on the history of the sample as on the laboratory examination. If he knows the conditions under which the sample was taken, such as the kind of water, well, lake, river, etc., the lay of surrounding land (hilly, flat, rocky, sandy, etc.) and the depth, temperature and time, he can give a better and more accurate report of the water.

Simple Tests for Pure Water that a Plumber Should Know

Color: Fill a clean long bottle of colorless glass with the water; look through it at some black object. It should look colorless and free from suspended matter. A muddy or turbid appearance indicates soluble organic matter or solid matter in suspension. Odor: Fill the bottle half full, cork it, and leave it in a warm place for a few hours. If when uncorked it has a smell the least repulsive, it should be rejected for domestic use. Taste: If water at any time, even after heating, has a disagreeable taste, it should be rejected.

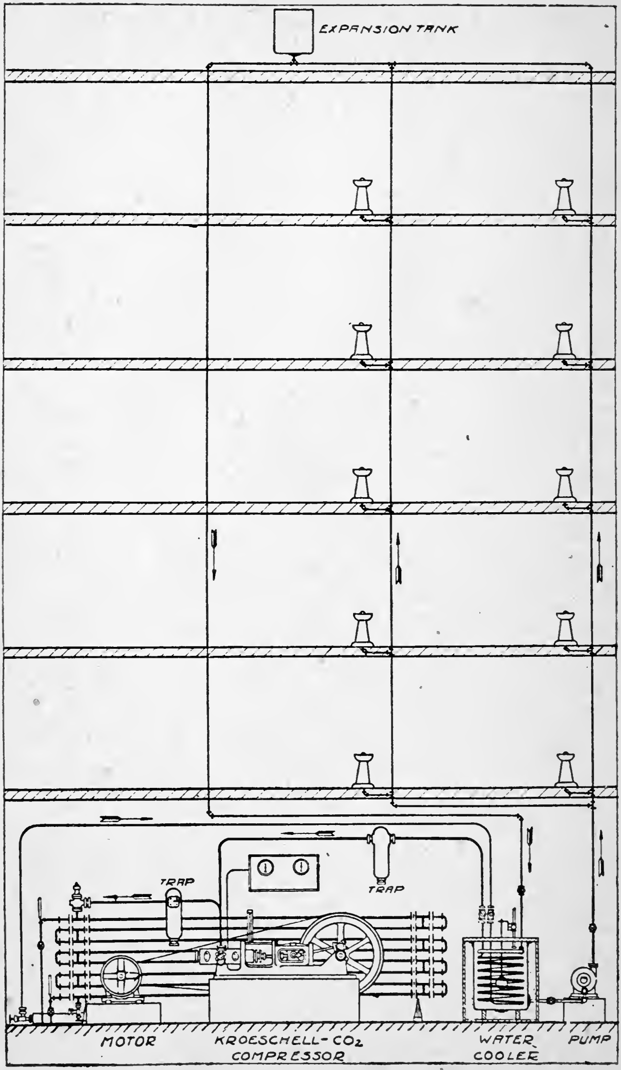
A simple semi-chemical test is known as the "Heisch Test." Fill a clean pint bottle three-fourths full of water; add a half-teaspoonful of clean granulated or crushed loaf sugar; stop the bottle with glass or a clean cork and let it stand in a light and moderately warm room for forty-eight hours. If the water becomes cloudy, or milky, it is unfit for domestic use.

Drinking Water Cooling Systems

In a Drinking Water Cooling System for an office building, public building, factory, etc., the water is generally cooled in an open water tank in which are placed refrigerating coils. These coils may be either direct expansion or brine coils.

Where Carbonic Gas is used as the Refrigerating medium direct expansion coils are generally used as no harm would be done if there should be a leak in the coils.

In order to instantaneously supply water at any drinking fountain the water should be circulated by means of a pump. Sufficient water should be circulated so as to keep the temperature of the water at the desired point. The amount of water that must be circulated is dependent upon the length of the runs, and enough water must be circulated to carry away the heat absorbed in the circulating system. From three to six times the amount of water consumed should be circulated,



DRINKING WATER COOLING SYSTEM

depending upon the length of the water circulating piping.

The water circulated should be taken from the tank by means of a pump and circulated through the building as shown on the accompanying drawing.

The water supply to the tank should be regulated by a float valve so as to insure a constant water level in the tank.

If the water supply to the tank and the water return from the circulating system is distributed over the cooling coils by means of a spray pipe, the best results are obtained and a smaller amount of cooling coil is required. In water coolers where the water is sprayed over the coils, about 30 lineal feet of 1¼" pipe are required per ton of refrigeration.

The water cooler should be properly insulated, and the top of the tank should be provided with a cover so that the cooler may be readily cleaned.

A good method of estimating the size of a drinking water circulating system is to figure that a 5-ton machine will take care of 1500 people.

In figuring the cost of installation of this system the cost of the fountains and piping must be added to the cost of the refrigerating machinery and its erection, as in the latter are included only the machine, motor, pump, coolers, and other items strictly connected with the machine. The piping, including labor, pipe, and fittings, generally comes to about $1.00 per running foot. The price depends to a great extent on the length of the piping.

Circulating Ice Water.

When cooling drinking water for department stores, office buildings, hotels and other public buildings, allow 5 tons refrigerating capacity for every 100 gallons water per hour consumed, thus allowing for waste and radiation losses through water pipe covering. In hotels with fountains in every room allow one ton total refrigerating capacity for 50 to 75 rooms. Drinking water fountains in corridors of public buildings are opened so often that one ton of refrigerating capacity is required per every six to eight fountains. Two gallons of drinking water per minute is usually circulated per

ton of total refrigerating plant capacity. In office buildings having drinking fountains in every office allow one ton capacity per 40 fountains.

Factory superintendents, architects and engineers, who are most active in utilizing modern methods of doing things right, consider that factories and buildings should be equipped with a mechanical refrigerating plant for cooling drinking water.

The old bucket and dipper method, or common drinking cup, is not only unsanitary, expensive and wasteful of time, but on account of the temptation to drink excessive quantities at infrequent opportunities it affords, has proven very injurious.

Lack of proper supply of water at improper temperatures lowers the personal efficiency, and decreases production of the employee.

The new method is to install a sanitary, porcelain, self-closing bubbling cup, in combination with a carbonic system of refrigeration.

Ice vs. Mechanical Refrigeration: According to accurate cost records of one of the largest American corporations, it was discovered that the old fashioned ice water cooler is 300% more expensive to maintain that a mechanical refrigerating plant, considering the excessive cost of ice, and labor for handling ice, as compared with the cost of power and supplies for a refrigerating plant. The electric power required is only one kilowatt maximum demand per 100 employees.

Water Pipe Line Design: The ideal plant to install is the self-closing, bubbling fountain, interconnected by properly insulated pipe lines, through which water is recirculated at a velocity not exceding 195 feet per minute. The water, after traveling through not more than to thousand feet of pipe, usually rises about five degrees in temperature, when it should be returned to refrigerating plant and re-cooled. Physicians agree upon this point, that water at a temperature of 40 to 45 degrees Fahr. is most acceptable, as it acts as a mild heart stimulant and reduces the temperature of the body.

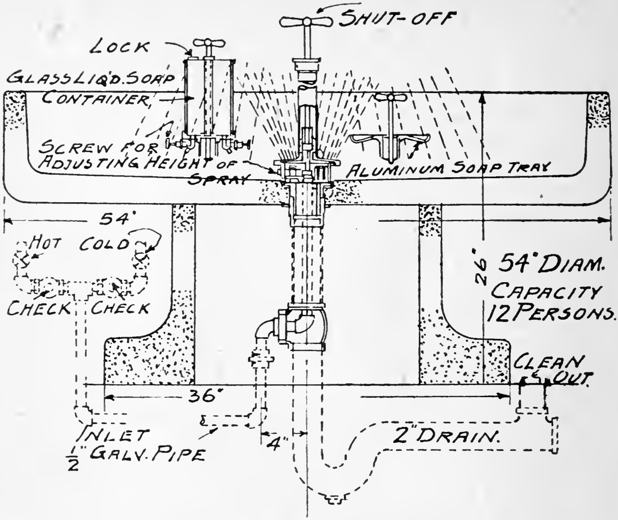
Quantity of Water: Factory hands performing very hard manual labor, such as required in steel

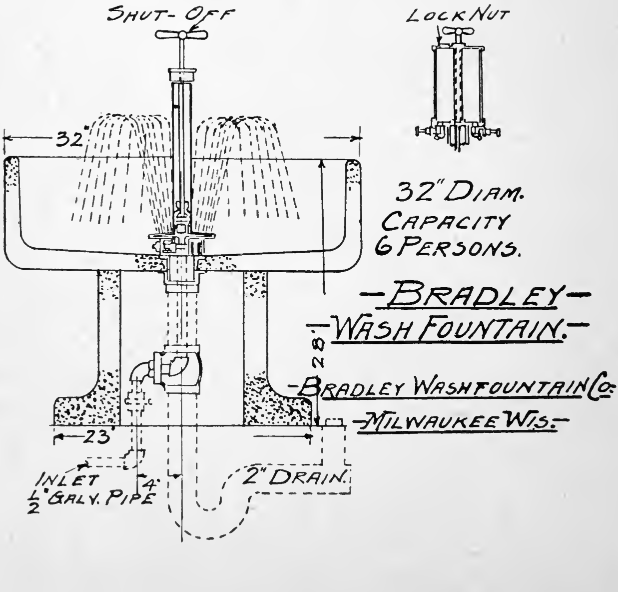
mills, consume and waste one quart of water per hour per man. In other industries where lighter manual labor is required, an allowance of one pint per hour per person is a safe estimate, including waste.

Pipe Covering: Commercial cork drinking water pipe covering is made of material of such thickness and quality as to permit a maximum transmission of 4 to 7 B. T. U.'s per lineal foot of pipe per degree difference per twenty-four hours. Ample allowance for this loss must be made before deciding upon capacity of ice machine.

Sanitary Wash Stands for Factories, etc.

The sanitary laws of almost all the states in the Union demand separate sanitary washing facilities for persons employed in factories, etc. Several kinds of wash stands, accommodating from 6 to 8 persons to wash at the same time, are on the market and have been installed for several years. All are of enameled cast iron and equipped with from 6 to 8 independent cold and hot water combination faucets. The persons washing mix the water to desired temperature, hold their hands under the stream from the faucet, collecting the water in their hands and wash hands or face, and then, as a rule rinse off with cold water. There is no plug or stopper to the sink which merely acts as a collector of the waste water and is connected by means of a trap to the waste line. The "Bradley Wash Fountain" is a new device, circular in shape, and made of "marmorite" or "granite" concrete and finished very smooth. They are made in two sizes, 32″ diam. for 6 persons and 54″ diam. for 12 persons, occupying less space and accommodate more people than the rectangular sinks. Instead of an independent faucet for each person, delivering the water in a solid stream, this fountain has one single device delivering the water in a spray from which all the people receive the water. It is a more convenient way and, besides, is a great saver of water as in the spray form not any more water is used for from 6 to 12 persons than what is used


SHUT-OFF
LOCK
GLASS LIQ'D. SOAP CONTAINER.
SCREW FOR ADJUSTING HEIGHT OF SPRAY
ALUMINUM SOAP TRAY
54"
HOT
COLD
CHECK
CHECK
26"
54" DIAM.
CAPACITY
12 PERSONS.
CLEAN OUT.
36"
INLET
1/2" GALV. PIPE
4"
2" DRAIN.


SHUT-OFF
LOCK NUT
32"
32" DIAM.
CAPACITY
6 PERSONS.
—BRADLEY—
—WASH FOUNTAIN.—
28"
-BRADLEY WASHFOUNTAIN CO.
-MILWAUKEE WIS.-
23"
INLET
1/2" GALV. PIPE
4"
2" DRAIN.

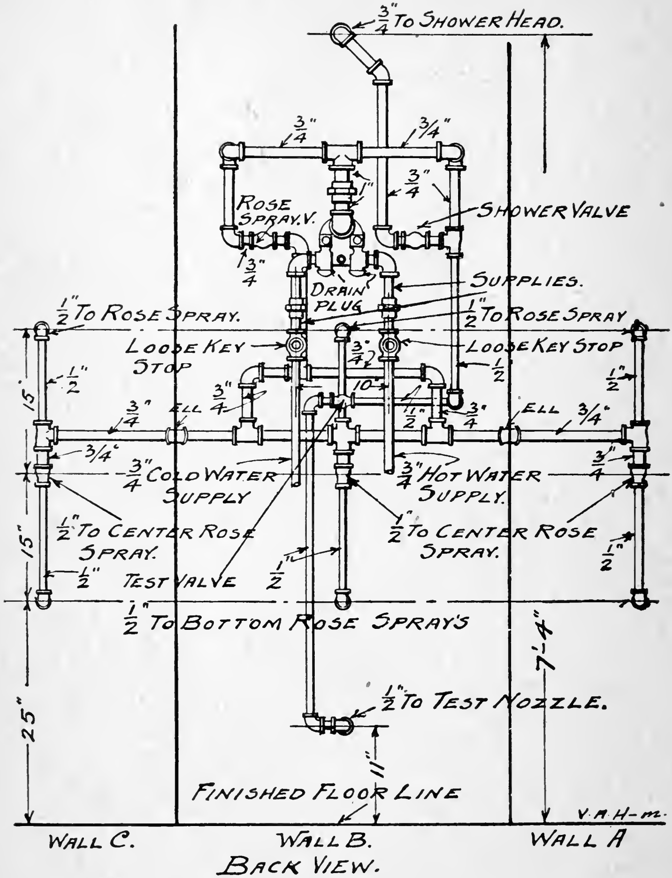
by a single person when the sink is equipped with the old style combination faucets, from which the water is running in a solid stream during washing. Fountain is supplied with a combination hot and cold water mixing device and several soap trays. The two accompanying cuts illustrate this fountain.

BRADLEY WASH FOUNTAIN

Modern Shower

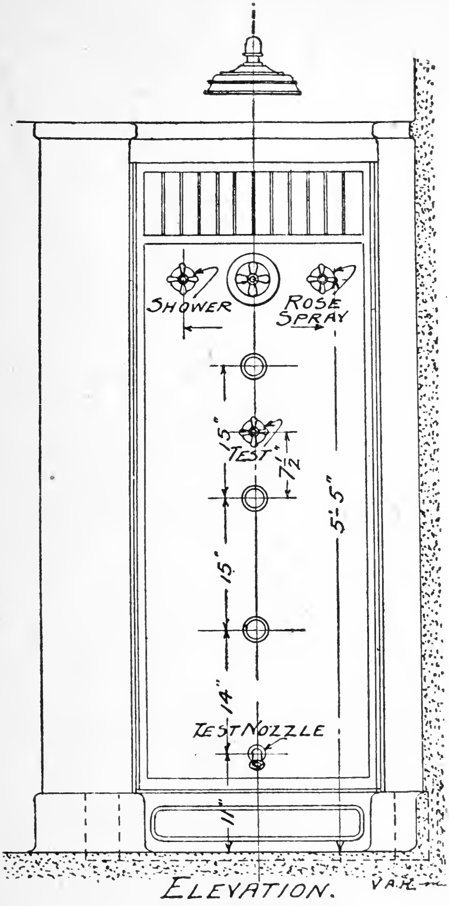
On the three following pages are shown in detail a Rose Spray and Shower bath, equipped with J. L. Mott fixtures. This kind of installation is used in almost all up to date hotels, clubs and residences. Being more sanitary and better in every respect, the shower is rapidly taking the place of the old fashioned bath tub.

These three sketches, as also the sketches of the swimming pool, are more than mere pictures. They go into the details of construction, giving the size of the shower stall and swimming pool, shows the fixtures and how to arrange them. and gives the sizes of pipes, valves, etc.

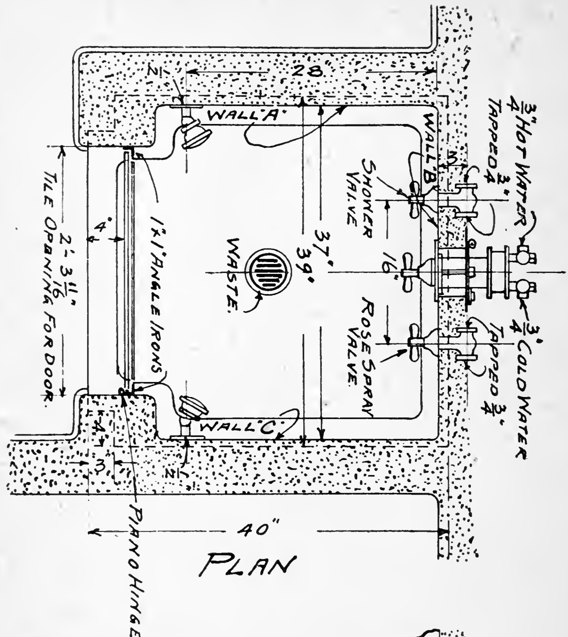


Notice.
Closet Should Be Provided Behind Stall For Access to Piping and Valves for Repairs.

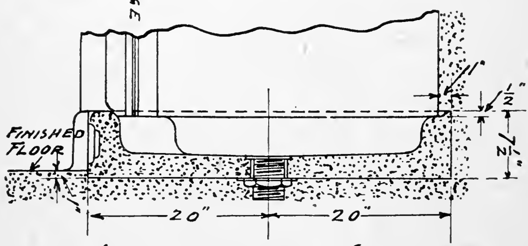
Rose Spray and Shower Bath.
Sketch "A"



ROSE SPRAY AND SHOWER BATH.
SKETCH "B"



PLAN



LONGITUDINAL SECTION.
OF RECEPTOR.

ROSE SPRAY AND SHOWER BATH.

SKETCH "C"

Specification for the Supply, (Filtered and Sterilized Water) Circulation and Drainage System for Swimming Pool

General:

The following specification covers a "Standard" sized swimming pool (20x60′) and the apparatus required for the complete system consist of the following:

Circulating Pump the suction end of which shall be connected to the two circulating returns at the deep end of pool. This pump will also be used for vacuum cleaning of the pool and for this purpose the inlet and discharge shall be by-passed as hereinafter specified.

Filter to which the discharge from pump is connected.

Heater to which the filtered water supply is connected at the bottom. From top of heater—the heated-filtered water shall be connected to the R. U. V. Sterilizers.

R. U. V. Sterilizers to the inlet of which connection is made from the heater. From the outlet of the sterilizer conection is made to the two supply inlets at shallow end of pool.

Circulating Pump:

Provide and place where shown adjoining deep end of pool, a circulating pump No. 162 type "C" two stage Turbine pump, manufactured by the Chicago Pump Company, or pump of other make fully equal thereto, with 2″ suction and discharge and a capacity of 75 gallons per minute against a head of 70 feet.

Pump to be bronze fitted with enclosed type balanced impellers, self-oiling removable bronze bearings extending through entire length of pump.

Pump to be mounted on a heavy iron base and direct connected by means of a flexible coupling to a 5 H. P. motor of type to accommodate available current. Motor to be provided with switch and fuses, all mounted in D Type steel box which shall be placed on wall near pump. The pump to be provided with a ¾″ water supply connection with gate valve to be used for priming pump when desired.

Connect the 2" suction inlet of pump to the 2½" circulating return from end of pool and provide the connection with a gate valve and two swinging brass check valves.

From discharge of pump run a 2" line to inlet or filter.

Pump and motor shall be placed on a concrete foundation which unless otherwise directed shall be 12" high above floor and 2" wider all around than cast iron sub-base. Exterior of foundation to be smoothly troweled and finished with a beveled edge at top. All anchor bolts must be properly set in place.

Filter:

Furnish and set up complete where shown an International Filter Co.'s Style "I" vertical type pressure filter or other make fully equal thereto, 60" diameter, 74" high, with 3" inlet and outlet connection, capacity 60 gallons per minute, based on a rate of 3 gallons per square foot per minute at 30 to 35 pounds pressure. Filter to be complete with all immediate pipe connections and valves and shall be provided with an automatic coagulating device with regulating valve.

Connection from pump to filter to be 2" increased to 2½" and from filter to bottom of heater 2½". Provide connection to heater with a 2½" swinging brass check valve.

The regular operation of the filter will be to purify the water from the pool, constant circulation of which is maintained by means of the circulating pump. From the filter the water passes to the heater. The filter shall be by-passed so that the filtered water can be delivered direct to the pool through the regular inlets. Run a 2½" drain from filter to sewer.

Provide proper concrete foundation for filter.

Heater:

Note: See last page "Boiler Capacity" where available steam pressure is less than 15 lbs.)

Provide and place where shown a Clow A-6575 No. 2 automatic water heater, or equal, complete with all trimmings such as a diaphragm steam valve, thermostatic temperature control, pressure gauges, thermometer, water relief valve, steam

trap and drip connection. Cold water supply to heater shall be 2″, hot water outlet 2″, steam supply 2″, steam return 1″. If the steam pressure exceeds 25 pounds—place a Fisher or equal steam pressure reducing valve on the steam supply, set so as to reduce the pressure to 25 pounds. Heater to operate on direct steam pressure of from 15 to 25 pounds.

The 2″ cold water supply to heater shall connect to same at the top and be provided with a swinging brass check valve and gate valve.

Connect a 2″ line from filter to bottom of heater properly valving the same and also placing a swinging brass check valve on the connection. Take off a 2″ drain from bottom of heater running same to sewer and place a gate valve on this connection.

Take off from top of heater a 2″ hot water outlet connection to the sterilizers, providing gate valves where shown and by-passing the sterilizers.

R. U. V. Sterilizers:

Provide and set up complete where shown one Clow's or equal Ultra Violet Ray Sterilizer combination known as Type H-2-2 consisting of two H-2 sterilizers connected together and operating in series.

Type H-2 consists of a three part brass casting in the form of a Maltese Cross, the diameter being approximately 26½″ and width approximately 15″. When mounted on its cast iron stand, the total height is 41″ from the floor. Through the center of the casting is fixed a quartz tube packed at the ends against external water pressure. Inside this tube is suspended a mercury vapor lamp of the improved type tested and approved by the United State Public Health Service operating on 220 volts, D. C. and consuming an electrical energy of .77 k.w. The two Sterilizers will consume an electrical energy of 1.54 k.w. Inside the lamp box is equipped with the Improved Pratt Simplified Lamp Starter approved by the United States Public Health Service.

Inside the casting and forming a part of it, are six brass baffles which cause the water, in its passage through the Sterilizers, to flow around or near the lamp several times.

There is furnished with each H-2 unit a steel cabinet containing automatic control apparatus mounted on a marble panel, together with a voltmeter and ammeter. The ballast resistance is mounted on top of the steel cabinet.

The cabinet is provided with knockouts to accommodate the conduit carrying the service wires to the cabinet, and from the cabinet to the sterilizer lamp box.

The entire apparatus is approved and listed by the Underwriter's Laboratories.

Motor Generator:

Where 220 volts direct current is not available, the H-2-2 Sterilizer shall be provided with a motor generator set complete with cast iron base, G. E. motor of 3 h.p. capacity, and type to accommodate the current available, direct connected by means of a flexible leather link coupling to a G. E. generator of two k.w. capacity. A marble switchboard with voltmeter, field rheostat back connected and the necessary switches, fuses and wiring shall be furnished and mounted on angle iron frame attached to motor generator set base.

Suitable concrete foundation shall be provided for motor generator set, which shall be as hereinbefore specified for the circulating pump.

Swimming Pool Supply:

The swimming pool to be arranged for two supply inlets at the shallow end of pool which shall be placed about 12″ below the water line. The inlet fittings shall be Clow's M-3852, or equal, large bell supply of polished brass tapped for 2″ iron pipe.

Swimming Pool Circulation:

The system to be arranged so that the water from the pool is returned through a filter to the heater, by means of a circulating pump and there shall be placed at the deep end of the pool about 12″ above bottom, two circulating fittings with 5″ brass bar strainers and connections for 2″ iron pipe. These to be connected into a 2½″ circulating return which shall be run to pump.

Swimming Pool Overflows:

The gutter in swimming pool shall be provided with eight (8) overflows: three (3) on each side

and one (1) at each end and evenly spaced. The overflow outlets in gutter shall be Clow's M-3865 or equal, polished brass fittings, open waste with outlet connection for 2″ iron pipe and shall be connected to a 4″ drain of extra heavy cast iron soil pipe.

The 4″ cast iron drain shall be run to such sewer line as will properly drain the same and if no other drain is convenient it shall waste into the 6″ drain for swimming pool on the sewer side of the 6″ gate valve.

Vacuum Cleaning:

The pool shall be provided with a Tuec vacuum cleaning system—which shall consist of four 2″ inlet valve connections in pool; two at each side, a swivel bronze terminal and 3 foot brass handle with fittings and one six foot handle and one seven foot extension handle and 50 feet of special rubber hose.

The 2″ vacuum cleaner inlets in pool shall be connected to a 2″ gavanized iron suction line with galvanized recessed drainage fittings and the 2″ line shall be connected to the suction inlet of circulating pump and provided with a 2″ brass gate valve. Provide a 2″ by-pass on discharge line of pump with brass gate valve and run same to sewer. When using the vacuum cleaning system the by-pass will be opened and waste water from pool discharged into the sewer and must not be circulated through the filter. The discharge line from pump to filter must be provided with brass gate valve so that the filter can be cut out during the time the vacuum cleaning system is in operation.

Swimming Pool Drainage:

Provide for pool at its lowest point as shown on plan a Clow M-3860 or equal galvanized cast iron bottom pool outlet with removable bar strainer 14″ in diameter and outlet connection for calking into a 6″ cast iron elbow which shall be a Clow A-1190 or equal base ell with bell end for receiving outlet connections from pool and spigot end for calking into a 6″ Class B cast iron water pipe. Place a 6″ double gate valve with hub and spigot end where shown on plan placing the same in a cast iron valve box with cover marked "Drain" set

flush with finished floor. Provide a heavy wrought iron tee handle rod for operating valve.

When entire contents of pool cannot be drained into sewer by gravity, the following should be specified:

The 6″ cast iron drain from pool shall be run to the catch basin where shown and shall be about 12″ above bottom of basin. Provide a 6″ cast iron outlet from catch basin to sewer at such height as may be required to properly connect the sewer in street. Place the double 6″ gate valve herein before specified on this line.

Provide and place in catch basin a Chicago Pump Co., No. 242-5 L.G. bilge pump, or equal, of 100 gallons capacity per minute with 2½″ discharge with a h. p. 220 volt A. C. motor with necessary starter and switches but without automatic float control. Motor to be mounted on cast iron cover. Basin to be 3″ inside diameter and constructed under another contract but this contractor will be required to furnish at proper time the 6″ cast iron inlet and outlet connections. This contractor shall also make all necessary connections from discharge of pump to the 6″ iron drain on the sewer side of 6″ gate valve.

Boiler Capacity:

The installation of an R. U. V. Sterilizer system radically changes the heating conditions for swimming pools.

The R. U. V. Sterilizer makes it possible to retain the water in the pool for a year or more if desired—without changing the same. By adding fresh water to make up for the quantity lost by overflowing and vacuum cleaning, the entire contents of the pool are gradually changed; hence the boiler capacity for heating the water in a pool equipped with R. U. V. Sterilizers may be much less than would otherwise be the case.

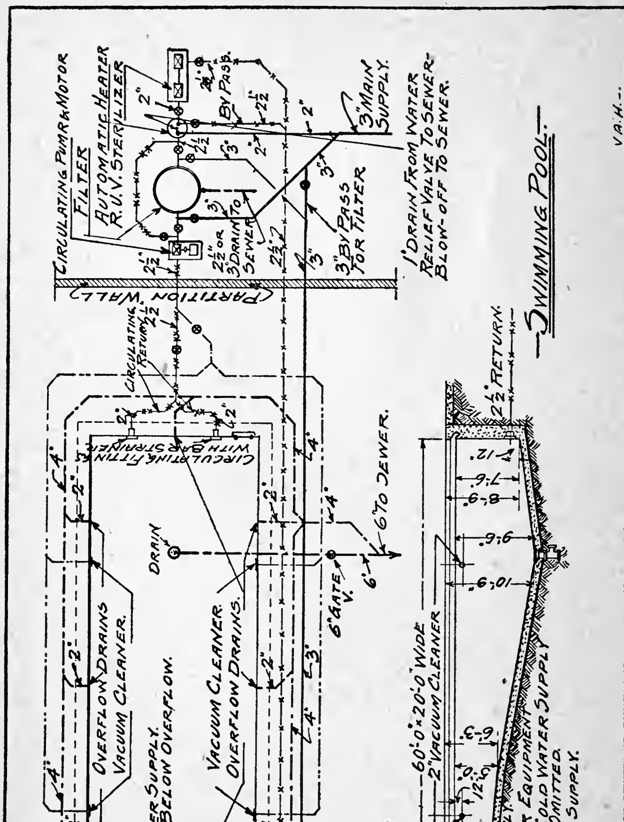
For a standard size 20′x60′ pool—a steam boiler —Clow's B-4733 No. 36-7-S having a capacity of 3,350 square feet (or Clow's equal) will be ample and capable of heating the entire contents of pool (approximately 56,000 gallons) in about 12 hours. The steam pressure should be from 5 to 10 pounds

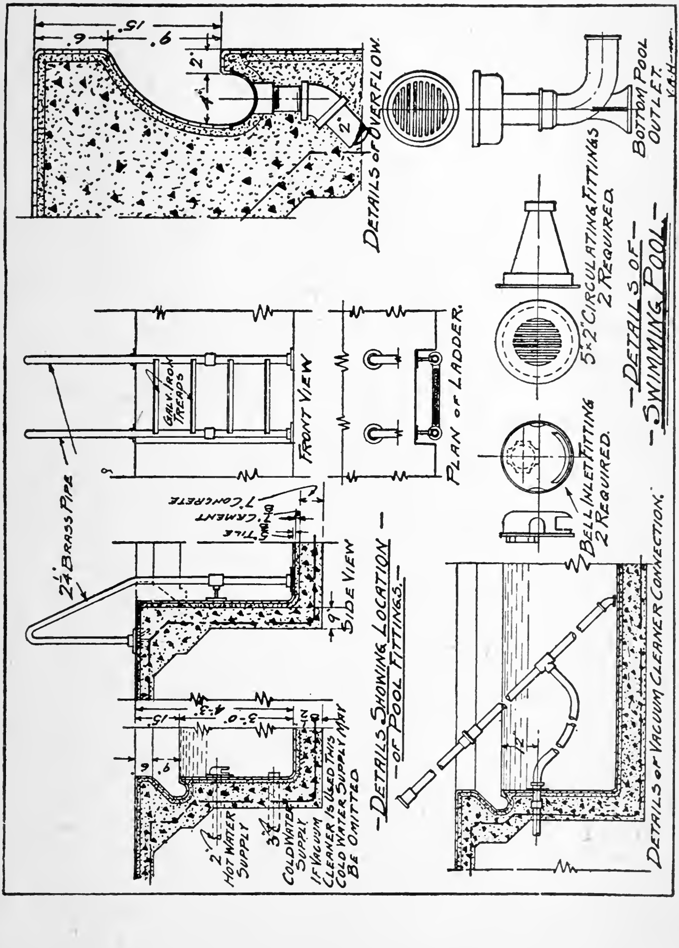
and in this case the steam supply to the heater should be 3½" or 4" instead of 2".

The heater should be installed so that return will be above water line of boiler for a gravity return and above water line of receiver and pump where the latter method is used for returning condensation to the boiler.

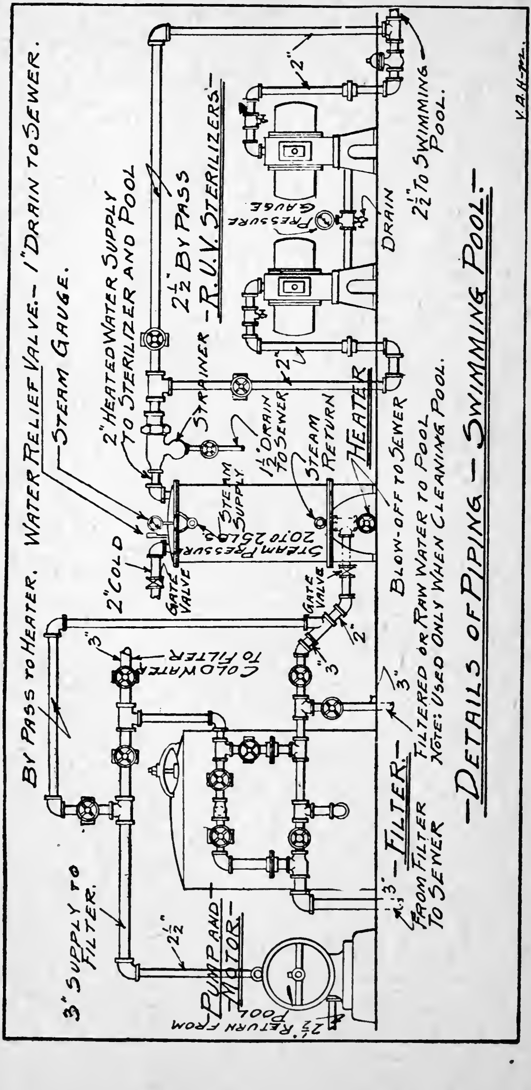
Wherever pools are used throughout the year it is recommended that the water be heated by means of a special steam boiler as above described. It makes the system less complicated and more economical in operation than if the system was arranged to be heated from the boilers of the heating plant for the building.

Note:—James B. Clow & Sons of Chicago, Illinois, with offices in the principal cities of the United States, manufacture and can supply everything required for the pool, and their apparatus are considered very excellent from every point of view by the author.


CIRCULATING PUMP & MOTOR
FILTER
AUTOMATIC HEATER
R.U.V. STERILIZER
BY PASS.
3" MAIN SUPPLY.
1" DRAIN FROM WATER RELIEF VALVE TO SEWER-BLOW-OFF TO SEWER.
3" BY PASS FOR FILTER
2½" OR 3" DRAIN TO SEWER
PARTITION WALL
CIRCULATING RETURN 2½"
CIRCULATING FITTINGS WITH BAR STRAINERS
DRAIN
6" TO SEWER.
6" GATE V.
OVERFLOW DRAINS VACUUM CLEANER.
COLD WATER SUPPLY. IN CENTER BELOW OVERFLOW.
VACUUM CLEANER. OVERFLOW DRAINS.
LADDER.
2" SUPPLY.
COLD WATER.
SWIMMING POOL.
2½" RETURN.
60'0"×20'0" WIDE
2" VACUUM CLEANER
3" COLD WATER SUPPLY.
IF VACUUM CLEANER EQUIPMENT IS USED THIS 3" COLD WATER SUPPLY TO POOL MAY BE OMITTED.
2" HOT WATER SUPPLY.
V.A.H.



Details of Overflow.
Bottom Pool Outlet.
5×2" Circulating Fittings
2 Required.
Bell Inlet Fitting
2 Required.
Details of Vacuum Cleaner Connection.
2¼" Brass Pipe
Galv. Iron Treads
Front View
Plan of Ladder.
7" Concrete
1" Cement
Tile
Side View
Details Showing Location of Pool Fittings.
Hot Water Supply
Cold Water Supply
If Vacuum Cleaner Is Used This Cold Water Supply May Be Omitted
-Details of-
-Swimming Pool-



—Details of Piping — Swimming Pool.—

The Use of Water Softeners

All mechanical engineers concede that hard water is a detriment to boilers and piping. When analyzed it is found to contain certain minerals that are destructive to iron and steel, which as a consequence shortens the life of both boiler and piping. I therefore advocate the use of a water softener for both high and low pressure boiler feed, as well as for domestic use.

A water softener prevents scaling and does away with the unnecessary labor of using boiler compounds such as are generally used daily by engineers everywhere. Do away with this nuisance!

Any engineer having anything to do with power plants where boilers are used can safely recommend a water softener of good type such as the "Permutit."

Boiler scale will not be found where soft water is used.

Make boiler washing a thing of the past by recommending a good softener.

"PERMUTIT" WATER SOFTENER

Permutit looks something like coarse sand, and its water softening properties are utilized by placing it in a tank and allowing the hard water to percolate through it. After it has abstracted its full quota of hardness, the water is shut off and the softener regenerated with a solution of common salt in water. The sodium of the salt replaces the lime and magnesia and the softener is brought back to its exact original condition ready to soften another quota of hard water.

The regeneration cycle is ordinarily arranged to take place at night when plants are closed, or two softeners are placed parallel to give 24-hour continuous service.

Water softened by Permutit differs from that attained by any other method, in that it is absolutely soft, by which is meant the hardness is reduced to zero. In addition it is clear, clean and ideal, not only for drinking but for the most exacting industrial uses. There is no possibility of "over dosage" as in chemical plants for no chemicals are added to the water and no expert supervision is required even

when the hardness of the raw water varies over a wide range. Operating and maintenance costs are lower per grain of hardness removed than for any other method of softening water, while the results obtained can only be compared with those that might be achieved with distilled water.

With the increasing scarcity of coal due to increased consumption and congestion of transportation and with the generally higher cost of fuel it is the duty of every one to investigate every possible way that fuel is wasted and how the wastage may be prevented. There is no doubt that the general consideration of burning the coal efficiently in the boiler furnace comes first, but the heating surfaces of the boiler must also be kept clean, otherwise the heat produced in the furnace cannot be utilized fully. Every engineer and fireman knows these things, but they have not been watched carefully in the past owing to the great wealth of natural resources. The time has come, however, when ways must be changed and every pound of coal made to count.

In boiler plants Permutit guarantees complete elimination of scale, sludge and mud from the interior of boilers and connections, and will do away with boiler cleaning altogether.

For Use in Laundries.

Laundries seeking the means of producing sweet-smelling, white, soft wash, at minimum washing costs, find the solution of their problem in "Zero-water" the unfailing consistent delivery of Permutit apparatus, and in Permutit washing methods, developed and installed by our laundry experts.

No laundry doing the average class of work need use more than 12 pounds of soap per $100.00 worth of work, with similar low soda consumption. Permutit equipped laundries in every state are washing with such low quantities of supplies every day; many use less. The average laundry owner pays for his Permutit Softener from the dividends it pays in a little over sixteen months' operation. Considering that he is washing in water containing no hardness, iron, or suspended matter, water that can deposit no "lime soap," that is not astonishing; and the absence of the "lime soap" is the reason behind the white, soft, sweet-smelling wash.

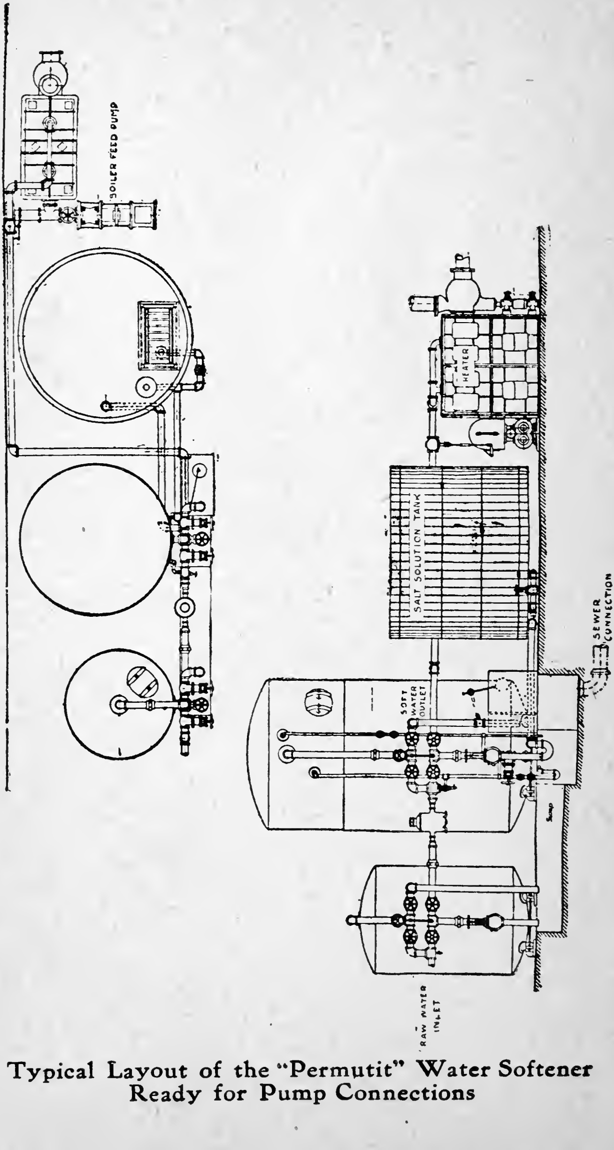
Investment and Operating Costs.

The comparative investments in different water-softening systems depend entirely on the composition of the water. Lime.soda plants remain fairly constant in cost with varying compositions, whereas exchange-silicate plants increase in size and cost with increase of hardness in the raw water. Cost of treatment depends also on the water composition and the proportion of temporary and permanent hardness. The cost of lime treatment alone is about one-third to one-half the cost of the corresponding salt for regeneration, but, as pointed out in the foregoing, the cost of the soda-ash treatment is about three times the cost of salt for regeneration. In conclusion, a typical case will be analyzed to determine the actual savings that would result from installing a water-softener without reference to the type used. Take a water of the following composition (same as water in the Bridgeport installation mentioned above):

			Grains Per Gal.
Total hardness,	as $CaCO_3$ =	130 p.p.m. =	7.7
Calcium hardness,	as $CaCO_3$ =	80 p.p.m. =	4.7
Magnesium hardness,	as $CaCO_3$ =	50 p.p.m. =	3.0
Alkalinity,	as $CaCO_3$ =	80 p.p.m. =	4.7
Temporary hardness,	as $CaCO_3$ =	80 p.p.m. =	4.7
Permanent hardness,	as $CaCO_3$ =	50 p.p.m. =	3.0

Assuming a boiler plant of 3000 hp., consisting of ten boilers with no returns using 12,000 gal. (45,400 l.) per hour raw feed water, the first cost including foundations and connections would be about $20,000. The cost of operation for chemicals would be about 3 cents per 1000 gal. (3785 l.). With a coal consumption of 1 pound (0.45 kg.) per 8 pounds (3.62 kg.) of water evaporated, the average daily consumption of coal would be about 150 tons. Assuming a price for coal at $4 per ton and a saving of 5 per cent for fuel, then the fixed and operating charges of water-softener would be.

	Per Year
288,000 gal. per day × 3 cents = $8.64..... =	$3,150
Labor of operation .... =	500
Interest and depreciation, at 10 per cent... =	2,000
Total	$5,650



Typical Layout of the "Permutit" Water Softener
Ready for Pump Connections

Flush Valves for Water Closets and Urinals

In the most effective and up to date plumbing installations the use of a tank with its complicated mechanism is discarded and in its place a flush valve is installed. In nearly all public buildings, such as hotels, office buildings, schools, court houses, factory buildings, etc., the flush valve is now almost entirely used, as the old style tank is easily gotten out of order, whereas a flush valve is simple and fool-proof. I advocate very strongly the use of these valves in all public buildings.

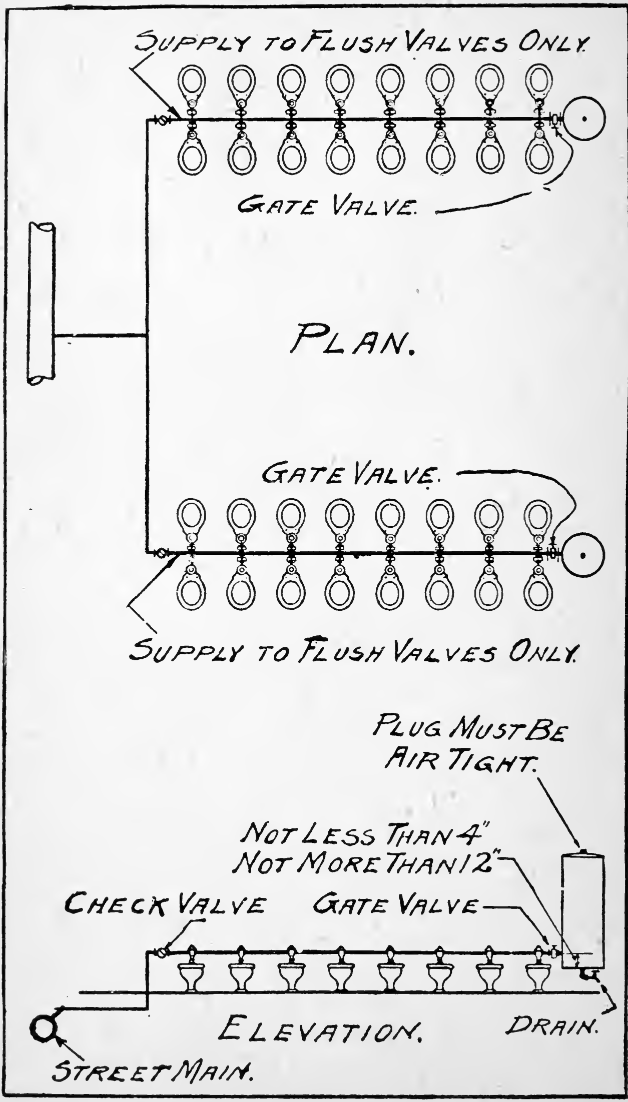
The water supply to a flush valve must have a rate of flow sufficient to properly flush the closet bowl. The pressure at the flush valve and the length of the supply line determine the size of pipe required. The size indicated in the table is suitable for one closet or three urinals. The pressure should never be less than 5 lbs. at the flush valve.

TABLE No 4	* Total feet of supply pipe from the flush valve to the street main or storage tank									
	5	10	20	30	40	60	80	100	150	200
Minimum Pressure at the Flush Valve in lbs.	Size of Pipe for One Water Closet									
5	1¼	1½	1½	1½	2	2	2	2½	2½	3
10	1	1¼	1½	1½	1½	1½	2	2	2½	2½
20	1	1	1¼	1¼	1¼	1½	1½	1½	2	2
30	1	1	1	1¼	1¼	1¼	1½	1½	1½	1½
40	1	1	1	1	1¼	1¼	1¼	1½	1½	1½
60	¾	1	1	1	1	1¼	1¼	1¼	1½	1½
80	¾	¾	1	1	1	1	1¼	1¼	1¼	1½

*** Add 10 feet for each 90° fitting**

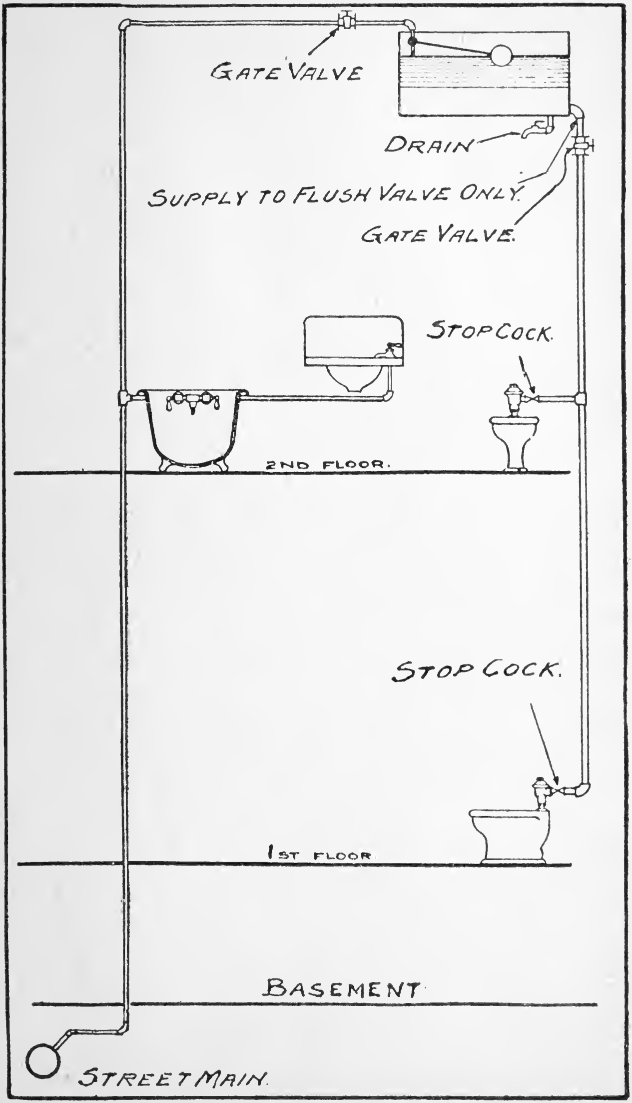
Red lead, white lead, or other pipe cement must not be used in the flush valve nor used in the piping. If the flush is too strong or causes a splashing, throttle the supply at the controlling stop. If the flush is not strong enough to properly flush the fixture, it denotes insufficient supply. Of the three accompanying drawings Figure No. 1 shows a typical installation of flush valves with small

FIG No 1.



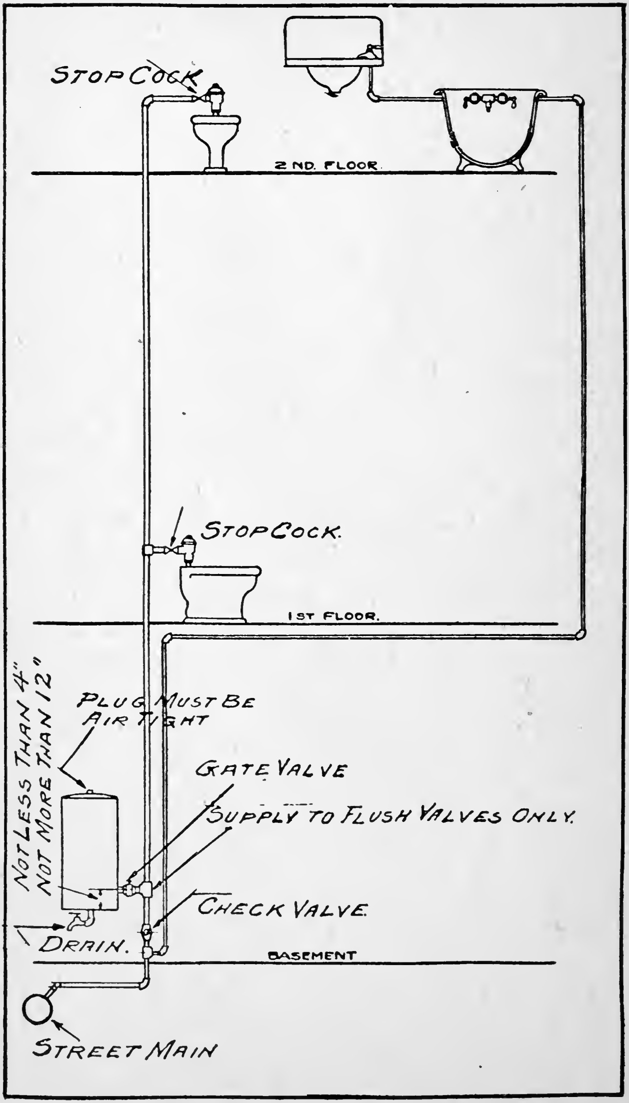
PLAN AND ELEVATION OF A BATTERY OF WATER CLOSETS EQUIPPED WITH FLUSH VALVES

FIG. No 2.

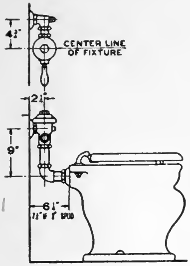


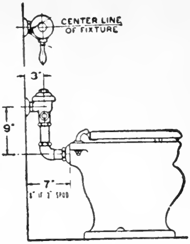
WATER CLOSETS EQUIPPED WITH FLUSH VALVES

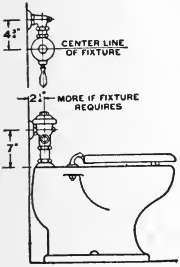
FIG. No. 3

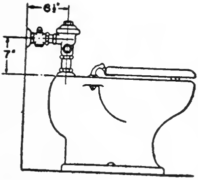


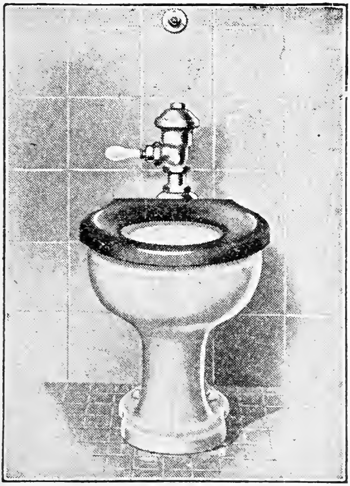
FLUSH VALVE EQUIPMENT











The measurements given here of the Royal Flush Valve will be of great assistance to the practical Plumber

supply from street main. Made sufficient by compression tank, Figure No. 2 shows a typical installation of flush valves with gravity tank. Figure No. 3 shows a typical installation with small supply from street main made sufficient by basement compression tank.

There are several makes of flush valves on the market. One of the oldest and best is the Ro Flush Valve.

Water Service Pipe

An application must be made to the water company or municipality and they will send one of their own men to put in a tap of the required size in the main. They will not allow the plumber to do so. From this tap the plumber runs the service, usually of extra strong lead pipe and never less than ¾" for small jobs, to the building and makes connections. A great many water companies and municipalities require a meter, and where so required should be placed as shown in Figure 1. Care should be taken to place the meter in such a place that there will be no danger of freezing.

The service pipe is usually constructed as shown in Figure 1. The valves, etc., necessary for a service pipe are as follows: One stop at tap, one stop with curb box at curb, one stop and waste located inside of building. These valves being under ground and hard and expensive to replace should be extra heavy all brass of best grade and should be placed in an upright position.

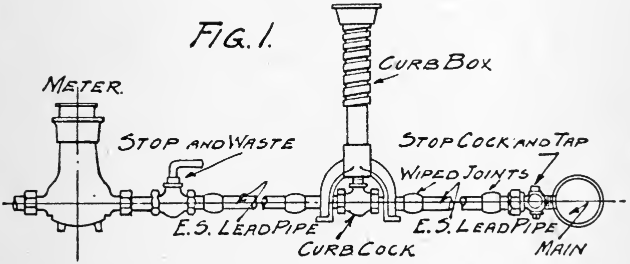
When a large service pipe is required and a lead pipe proves expensive, it is customary to install an iron or steel pipe. This pipe should, of course, be galvanized, and after laid should receive a coat of red lead and oil, or asphaltum, and be covered with tar paper. Concrete and cinders, especially the latter, will destroy a galvanized pipe in a short time, as the galvanizing is cut away at the threads and, perhaps, scraped off at several places, exposing the iron and causing it to rust.

Refilling of Trench

Refilling of the trench should receive careful consideration. Refilling earth should be well soaked and tamped down. This is often carelessly done, resulting in a settlement. Concrete walks laid over the trench will settle and crack. The same amount of earth excavated should also be used in refilling. This can be done if about 6 inches of earth is filled in, then soaked and tamped down; then another 6 inches of earth soaked and tamped down; and, so on until the trench is filled.

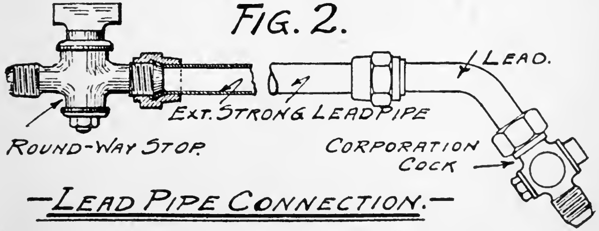
Figure 2 shows a patent lead connection, strong and durable, and is very convenient to use when there is a limited space and consequently hard to get at and wipe the joints.

FIG. 1.



—MOST COMMON WATER SERVICE CONNECTION.—

FIG. 2.



—LEAD PIPE CONNECTION.—

The wonder of the age, something that has never been known to the plumbing trade before—is this wonderful water-auger.

It is Essential to Every Plumber and Water Company to Have a Snow Water Auger Because of Its Economy and Efficiency

---

The Way to Clean a Stop Box:

When a stop box is full of dirt in inaccessible places especially where a stone or cement sidewalk can not be dug up, the Snow Water Auger screwed to a garden hose. Screw plug in side opening place the Auger in the stop box when the water is on a fine cutting stream will dissolve the dirt till the Auger reaches the curb cock then take out plug and screw it in the end, put it down again to the bottom of the box and all dirt will come to the top and box is clean. Then screw a Snow Stop Box Cover and the box is same as new.

HOW TO OPERATE THE SNOW WATER AUGER.

To bore for a pipe without digging up the ground. Excavate a ditch 8 or 10 ft. long, the depth required.

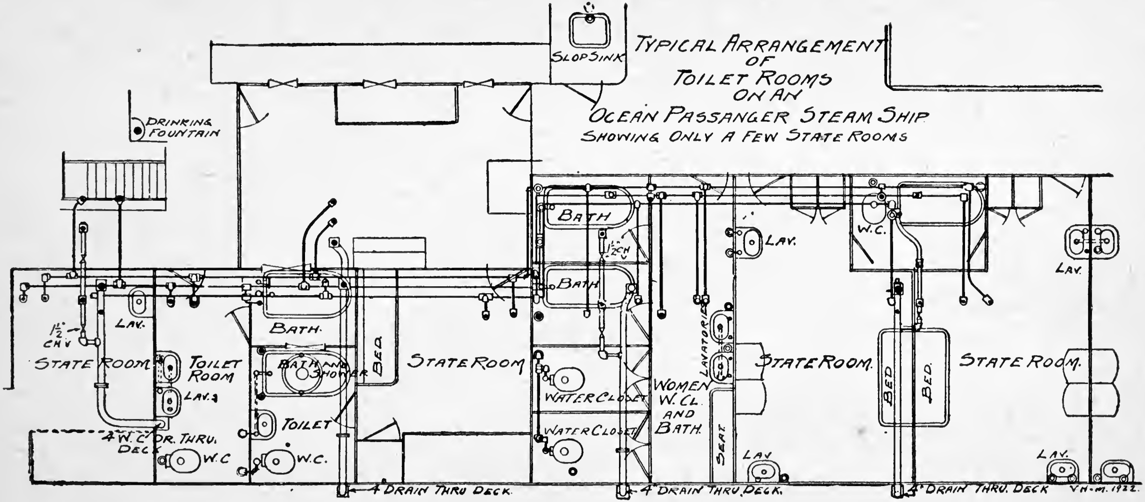
Dig a pit deeper than the bottom of the ditch to receive the discharge water, plug up the side opening, screw the **Auger** on the end of iron pipe, and a hose at the iron pipe and hose attachment at the other end. Enter the **Auger** perfectly straight, turn on the water, as the cutting streams from the **Auger** bores through the ground, slide the pipe back and forth, about a foot so as to release the water and dirt, keep adding pipe in length required.

If it strikes a stone, work it back and forth, it will wash out the dirt, and drop down, so the **Auger** will pass by.

If the hole wants to be made larger, screw the plug in the end of the **Auger,** and use the side opening, and operate the same as above.

It is also used in cleaning stoppage in sewers.

The first operation pays for itself.



Sectional diagram showing a typical layout of plumbing on an ocean going steamer.

—TABLE 4.
—SHOWING RELATIVE DISCHARGING—
—CAPACITIES OF PIPES.—

	1/2"	5/8"	3/4"	1"	1 1/4"	1 1/2"	2"	2 1/2"	3"	4"	6"	8"	10"
1/2"	1												
5/8"	1.7	1.											
3/4"	2.9	1.7	1.										
1"	6.2	3.5	2.1	1.									
1 1/4"	10.9	6.2	3.7	1.8	1.								
1 1/2"	17.4	10.0	6.0	2.8	1.6	1.							
2"	37.8	21.7	13.0	6.1	3.5	2.1	1.						
2 1/2"	65.5	37.5	23.1	10.7	6.1	3.8	1.8	1.					
3"	110.5	63.2	38.0	17.9	10.1	6.3	2.9	1.6	1.				
4"	189.0	108.3	65.0	30.6	17.3	10.8	5.0	2.8	1.7	1.			
6"	527.0	302.0	186	87	49	30.5	14.2	8.0	4.8	2.8	1.		
8"		650	418	195.3	108.6	67.2	31.6	17.9	11.2	6.0	2.1	1.	
10"								31.9	19.7	10.6	3.7	1.8	1.

—SIZE OF C. I. DRAINAGE MAIN REQUIRED FOR— GIVEN SQ. FT. OF SURFACE TO BE DRAINED.
(INCLUDING ROOF-SOIL PIPES AND GROUND AREAS)

IF VITRIFIED CLAY PIPE, USE ONE SIZE LARGER.

DIAM.	FALL 1/8 INCH PER FOOT	FALL 1/4 INCH PER FOOT.	FALL 1/2 INCH PER FOOT.
4 INCH	1500 SQ. FT.	1800 SQ. FT.	2500 SQ. FT.
5 "	1800 " "	3000 " "	4500 " "
6 "	3000 " "	5000 " "	7500 " "
8 "	6000 " "	9100 " "	13600 " "
10 "	9000 " "	14000 " "	20000 " "

V. A. H—m.

Table No. 4

EXPLANATION OF TABLE OF RELATIVE PIPE DIAMETERS.

The figures in the body of the above table give the number of pipes of a given diameter that are equal to one pipe of a larger diameter.

This table is based on conditions similar to those at a residence or other small building. For power plant or other similar conditions the table is only approximate.

Example: How many ½-inch pipes are equal to one ¾-inch pipe?

Under column marked ½-inch at top of table follow down column to figures opposite ¾-inch and read 2.9; that is to say, a ¾-inch pipe has a carrying capacity equal to about three ½-inch pipes.

Example: What diameter of pipe will be required to supply three ½-inch pipes, one ⅝-inch and one ¾-inch pipe?

Solution: Reduce all of the pipes to equivalent of ½-inch pipes.

Three ½-inch pipes....................3.0
One ⅝-inch pipe........................1.7
One ¾-inch pipe........................2.9
The combination equals 7.6 ½-inch pipes.

From the table we see that a one-inch pipe equals 6.2 one-half-inch pipes and a one and one-fourth-inch pipe equals 10.9 one-half-inch pipes. As we require the equivalent of 7.6 one-half-inch pipes, it would be necessary to use a one and one-fourth-inch pipe to supply the above combination.

—WEIGHT OF CAST IRON PIPE—

DIAMETER.	STANDARD WEIGHT PER FOOT.	EXTRA HEAVY. WEIGHT PER FOOT.
2 INCH	3½ POUNDS	5½ POUNDS
3 "	4½ "	9½ "
4 "	6½ "	13 "
5 "	8⅔ "	17 "
6 "	10⅓ "	20 "
7 "		27 "
8 "		33½ "

—WEIGHT OF WROUGHT IRON PIPE.—

DIAMETER.		WEIGHT PER LINIAL FOOT
⅛	INCH	0.245 POUND.
¼	"	0.425 "
⅜	"	0.568 "
½	"	0.850 "
¾	"	1.130 "
1	"	1.684 "
1¼	"	2.272 "
1½	"	2.73 "
2	"	3.68 "
2½	"	5.82 "
3	"	7.62 "
3½	"	9.20 "
4	"	10.89 "
4½	"	12.64 "
5	"	14.81 "
6	"	19.18 "
7	"	23.77 "
8	"	25.00 "

Weight of One Cubic Foot of Pure Water.

At 32 degrees Fahr. (freezing point) .... 62.418 lbs.
At 39.1 degrees Fahr. (maximum density) .... 62.425 lbs.
At 62 degrees Fahr. (standard temperature) .... 62.355 lbs.
At 212 degrees Fahr. (boiling point, under 1 atmosphere) .... 59.76 lbs.
Imperial gallon = 277,274 cubic inches of water at 62 degrees Fahr. .... 10 lbs.
American gallon = 231 cubic inches of water at 62 degrees Fahr. .... 8.3356 lbs.

WEIGHTS AND MEASURES

Cubic Measure.

1728 cubic inches	equal	1 cubic foot, cu. ft.
27 cubic feet	"	1 cubic yard, cu. yd.
128 cubic feet	"	1 cord, cd.
24¾ cubic feet	"	1 perch, P.

1 cu. yd. equals 27 cu. ft. equals 46,656 cu. in.

Measure of Angles or Arcs.

60 seconds (″)	equal	1 minute, ′.
60 minutes	"	1 degree, °.
90 degrees	"	1 rt. angle or quadrant.
360 degrees	"	1 circle, cir.

1 cir. equals 360° equals 21,600′ equals 1,296,000″.

Avoirdupois Weight.

437.5 grains	equal	1 ounce, oz.
16 ounces	"	1 pound, lb.
100 pounds	"	1 hundredweight, cwt.
20 hundredweight	"	1 ton, T.

1 T. equals 20 cwt. equals 2000 lb. equals 32,000 oz. equals 14,000,000 gr.

The avoirdupois pound contains 7000 grains.

Long Ton Weight.

16 ounces	equal	1 pound, lb.
112 pounds	"	1 hundredweight, cwt.
20 cwt. or 2240 lbs	"	1 ton, T.

Troy Weight.

24 grains	equal	1 pennyweight, pwt.
20 pennyweight	"	1 ounce, oz.
12 ounces	"	1 pound, lb.

1 lb. equals 12 oz. equals 240 pwt. equals 5760 gr.

Apothecary's Weight.

20 grains	equal	1 scruple, sc.
3 scruples	"	1 dram, dr.
8 drams	"	1 ounce, oz.
12 ounces	"	1 pound, lb.

1 lb. equals 12 oz. equals 96 dr. equals 288 sc. equals 5760 gr.

Size of Moleskin Wiping Cloths

Size of Wiping Cloth	Necessary Dimensions of Moleskin
4 in x 4 in.	16 in. x 8 in.
3½ " x 3½ "	14 " x 7 "
3¼ " x 3¼ "	13 " x 6½ "
3 " x 3½ "	12 " x 7 "
3 " x 3 "	12 " x 6 "
2¾ " x 3 "	11 " x 6 "
2½ " x 3 "	10 " x 6 "
2½ " x 2½ "	10 " x 5 "
2¼ " x 3 "	9 " x 6 "
2 " x 3 "	8 " x 6 "
1½ " x 3 "	6 " x 6 "

Sizes of Ticking Wiping Cloths

Size of Wiping Cloth	Necessary Dimensions of Ticking
4 in. x 4 in.	16 in. x 16 in.
3½ " x 3½ "	14 " x 14 "
3¼ " x 3¼ "	13 " x 13 "
3 " x 3½ "	12 " x 14 "
3 " x 3 "	12 " x 12 "
2¾ " x 3 "	11 " x 12 "
2½ " x 3 "	10 " x 12 "
2½ " x 2½ "	10 " x 10 "
2¼ " x 3 "	9 " x 12 "
2 " x 3 "	8 " x 12 "
1½ " x 3 "	6 " x 12 "

The Most Profitable Product for Soldering

One tablespoon ZINC CHLORIDE, add a few drops of water until it becomes as thick as paste. Keep it in a bottle well corked as it absorbs moisture. **(Caution Poison.)**

How to Clean Solder: Heat the solder to a cherry red. Skim out the dirt perfectly clean. Take a piece of Cyanide Potassium, size of hickory nut. Mash it in the ladle, fine as corn meal. Work thoroughly. Leave it in the pot until it has been cooled and heated 4 or 5 times.

Poison Caution: Do not handle with cuts or sores on your hands.

"S. R." Patented Trapeze Fittings for Practical Hangers

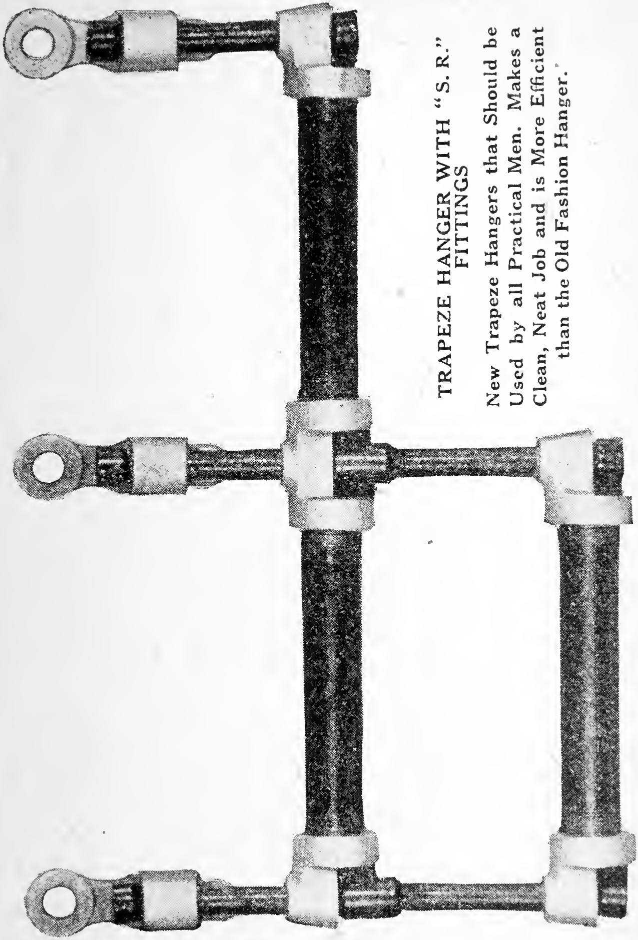
Realizing the necessity for a change from the usual makeshift arrangements such as strap iron and drilled pipe which are generally used for hanging pipe, radiators, etc. from ceilings, beams, or girders, we have designed these TRAPEZE FITTINGS with a view to furnishing a permanent as well as neat appearing support.

The above cuts illustrate the TRAPEZE FITTINGS employed in hanging a radiator with its supply and return pipes in addition to plumbers' pipes. Any arrangement or combination can be assembled on the job in a short time by using standard nipples or cut pipe in conjunction with the single and double TRAPEZE FITTINGS and the SLIP END FITTING. This SLIP END FITTING replaces the expensive and non-adjustable forged eye-bolt often used.

All fittings are accurately made from malleable iron and threaded to standard pipe sizes.

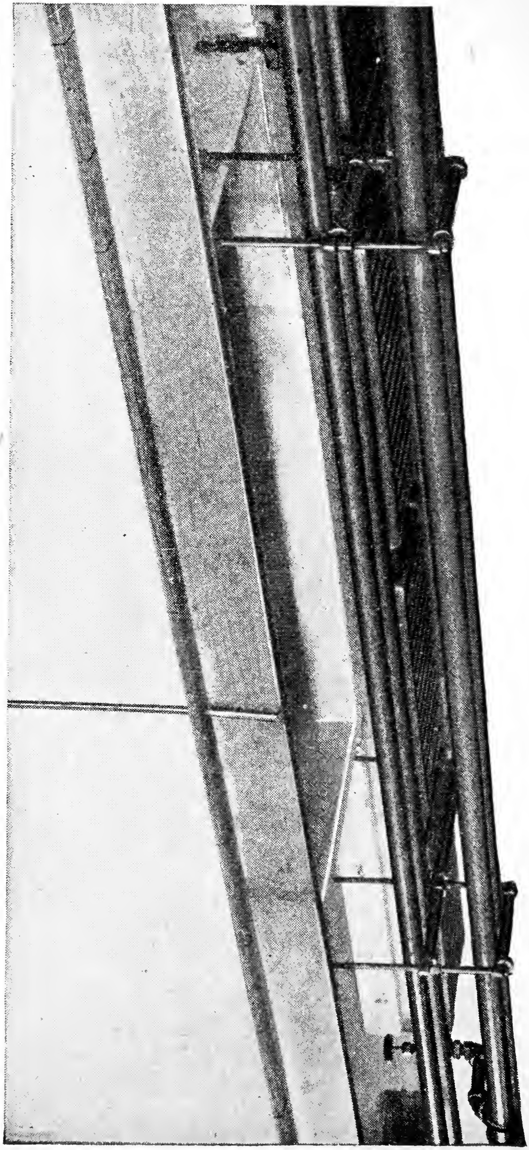
Prices are given in pamphlet, which will be sent upon request, by Kehm Brothers, Chicago, Illinois.

A practical man will always use a practical device. This fitting was invented by one of the best heating engineers in this country.



TRAPEZE HANGER WITH "S. R." FITTINGS

New Trapeze Hangers that Should be Used by all Practical Men. Makes a Clean, Neat Job and is More Efficient than the Old Fashion Hanger.



TRAPEZE HANGERS WITH "S. R." FITTINGS

This Illustration Shows the Trapeze Hanger in Position—Steam Pipes Below and Water Pipes Above.

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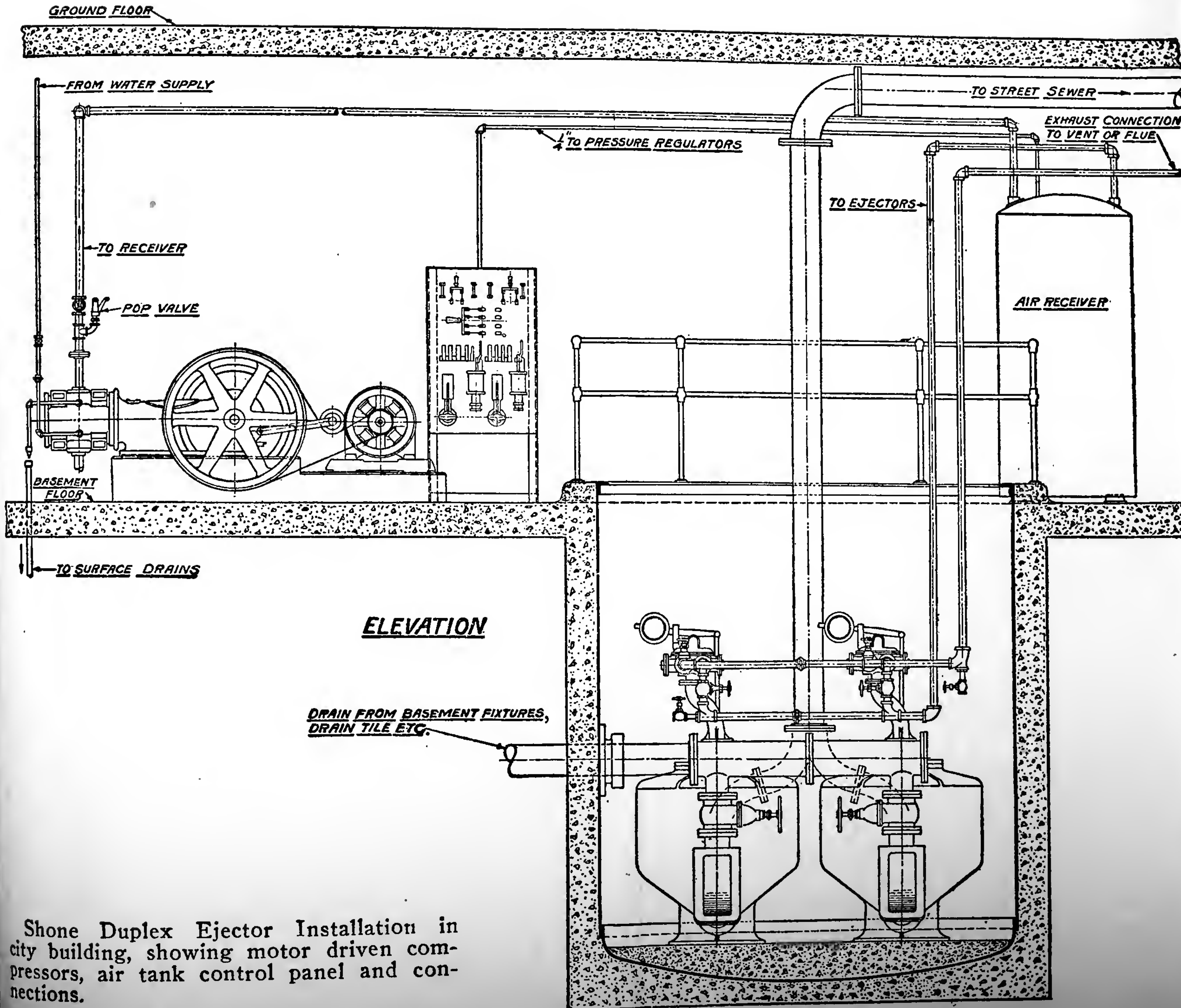
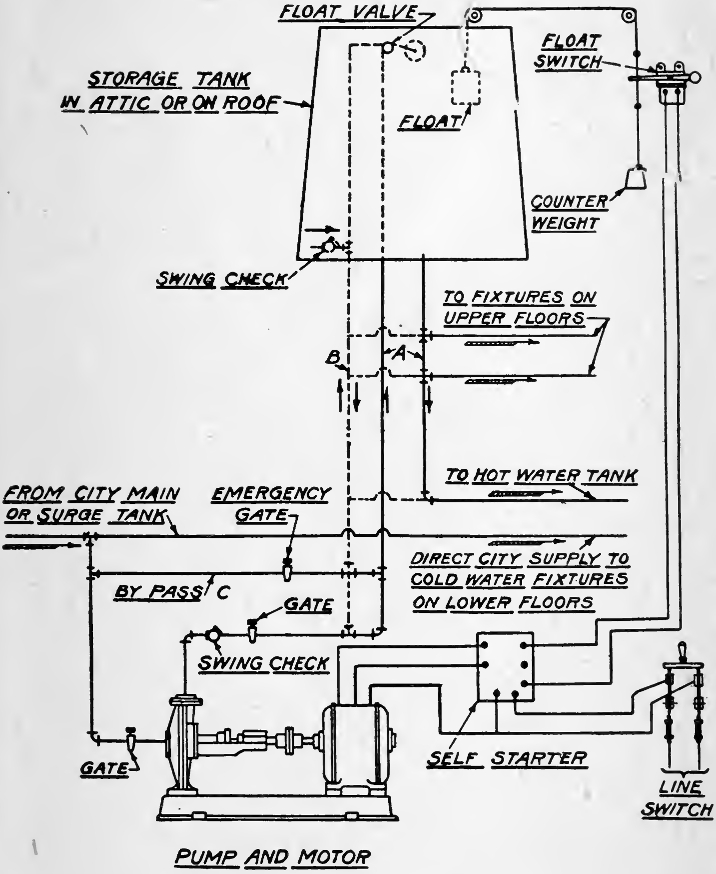


Shone Duplex Ejector Installation in city building, showing motor driven compressors, air tank control panel and connections.

Yeomans House Supply Systems

PIPING DIAGRAMS.



GRAVITY SYSTEM

NOTES.

1. A—Is two pipe system with separate supply pipes to storage tank, and from storage tank to hot water tank and fixtures on upper floors.

2. B—Is one pipe system with single supply pipe to storage tank, hot water tank and fixtures on upper floors.

3. With either system a float valve should be placed in tank to prevent tank overflowing in case of high city pressure passing through pump or through failure of float switch to operate.

4. A by-pass connection (C) with gate valve should be provided between city supply and riser to tank, to be used in case of accident to, or failure of, pumping equipment. The gate valve must always be closed when pump is in use.

5. No. 14 B. & S. twin conductor should be used between float switch and self starter at pump location.

NOTES.

1. Where absolutely noiseless operation is not essential conection A may be used and B omitted. Use B with plunger pump.

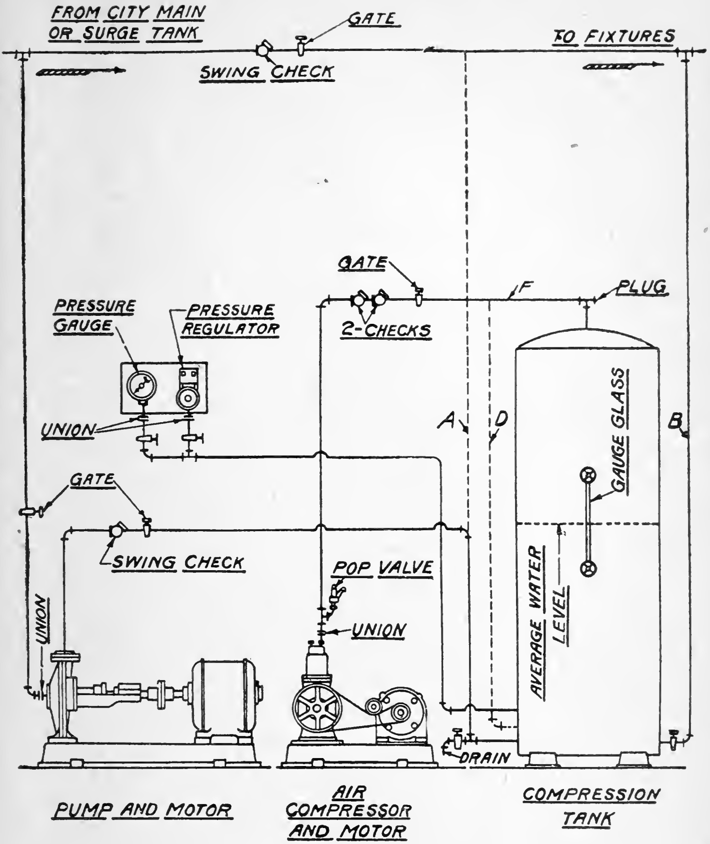
2. When plunger pump with suction lift is used furnish relief valve on discharge and foot valve on suction.

3. With motor operated air compressor use connection F. With hand operated compressor connection D may be used.

4. Water glass should be placed midway between top and bottom of tank and water level should be kept as near center as possible.

5. Manhole should be supplied in tank if required by city ordinance.

6. If horizontal tank is used manhole and drain should be at the same end and tank should pitch ⅛" to 1' toward that end.



COMPRESSION SYSTEM

The Shone System

PNEUMATIC SEWAGE EJECTORS.

The Shone Ejector consists of a closed sewage receiver or pot with special horizontal swing check valves below inlet and outlet (B) and an automatic pressure operated air valve mounted on top of the receiver and actuated by cast-iron bells connected to the valve by a system of links, lever and rocking valve shaft. The automatic air valve controls

the admission of air to and the exhaust from the receiver. The operation of the Ejector is as follows:

The bells are in their lowest position (the extent of their movement being limited to 1½ inches) the compressed air is cut off from the Ejector, and the interior of the Ejector is open to the atmosphere through the automatic valve and air exhaust pipe. The sewage, therefore, can flow through the inlet into the Ejector, which it gradually fills, until it reaches and begins to rise around the bell. When the latter is sufficiently submerged for its buoyancy to overcome the friction of the parts, both bells are raised into their upper position. The consequent movement of the lever throws over the automatic valve, closing the connection between the inside of the Ejector and the atmosphere, and admitting compressed air. This causes the check in the inlet to close, preventing a return in that direction; and the compressed air, pressing upon the surface of the sewage, immediately forces the contents of the Ejector downward through the bell-mouthed opening at the bottom, and out through the discharge check valve and the discharge pipe to the high level sewer.

The sewage passes out of the Ejector until its level falls to such a point that the lower bell is sufficiently exposed for its weight to throw the system out of equilibrium in the opposite direction. The bells consequently fall, reversing the automatic valve and returning it to its original position. This cuts off the compressed air, whereupon the outflow of sewage ceases and the check in the discharge valve closes, allowing the air within the Ejector to escape to the atmosphere. The sewage which has been ejected cannot return past the discharge valve; sewage again begins to flow into the Ejector, and this cycle of operation is repeated so long as sewage flows to the inlet and a supply of air is maintained.

The positions of the bells are so adjusted that compressed air is not admitted until the Ejector is filled, and is not allowed to exhaust until the Ejector is emptied down to the discharge level;

thus a specific quantity is discharged each time the Ejector operates.

A steel ejector pit surrounded with concrete is recommended for deep basements in city buildings. On other work reinforced concrete will ordinarily be found satisfactory.

When steel pit with dished bottom is used, a level concrete floor should be laid in bottom of pit before ejectors are set.

Anchor bolts for ejectors are not required.

Screening of sewage is not necessary.

Capacities are based on one discharge per minute, and therefore represent the actual quantity discharged at each operation. The ejectors can be operated at more than one discharge per minute in case of emergency, but this is not recommended for normal service.

Inlet connection may be made at either end or both ends of inlet tee or header as shown in drawing.

Air compressing plant may be located at any desired distance from ejectors. It should include air compressors, steam or electric driven, with automatic control and suitable air storage tank with pressure gauge, blow-off cock and relief valve. For electric drive, horizontal crank-and-fly-wheel compressors are recommended, although vertical high speed compressors may be used with satisfactory results and at lower first cost. For steam drive, direct acting locomotive type compressors may be used for small installations except where low steam consumption is desired. In larger plants and in all steam installations where low steam consumption is essential, crank-and-fly-wheel compressors should be used.

Underground air lines should be laid below frost line and with slight pitch toward ejector station. Gate valves should be inserted every 500 feet.

Air compressors, motors and controllers should be installed in duplicate.

Single ejectors from 400 to 1,000 gal. per min. may, if preferred, be installed in rectangular instead of round pits.

Estimating Plumbing

The successful plumbing contractor or estimator must know "his job"; in other words, on receiving the plans and specifications from the architect, whether it be a bungalow, large residence, apartment building, hotel, or industrial building, he must visualize to himself the plumbing and drainage systems called for as it will be installed.

The estimator must arrive at the correct interpretation of the specifications and the proper reading of the plans, and no set rule can be laid down to enable the beginner to master the technique of estimating plumbing.

It has been the writer's experience that the best estimators are seldom the graduate journeyman plumber or even the well established master plumber, but rather the educated young man who has made a study of the theoretical part of Sanitary Engineering and who has had the benefit of association with practical men and the opportunity to watch the installation of plumbing work under the guidance and supervision of a good practical master plumber.

The several trade journals with their helpful suggestions and practical illustrations are a necessity to the successful plumbing contractor or estimator, and I know of no source of knowledge that can be of more benefit to the young master plumber or estimator than the intelligent reading of a few hours each issue of some such paper as Domestic Engineering, Plumbers' Trade Journal, etc., etc. The man who has no time to read a trade paper or study the ideas and information so plainly set forth in such books as Johnson's Handy Manual, has no future in the plumbing business.

The first thing a plumbing estimator should get into his head is the fact that there is a per cent. of cost known as overhead expense that must be reckoned with on all jobs. This overhead expense is inevitable; no job can be figured or contract taken with safety if the overhead is overlooked or ignored. This theme has been so well covered by

the "Trade Extension Bureau," a national organization maintained by the National Association of Master Plumbers at Evansville, Indiana, who will be pleased to send their literature covering the subject to any plumbing estimator, that I will not attempt in this article to go further into this very important part of estimating.

As I have previously stated, plumbing cannot be figured by rule; every job is different and requires a separate estimate, though a few suggestions on time saving methods that are in use by some contracting plumbers, might be helpful. Costs cannot be given in this article, owing to the variation of cost of labor and material in different parts of the country.

Let us say you are figuring on a three story apartment building, which with the exception of the fixtures, the location of the water service and sewer stubs are nearly standard and can be divided into the following units, to arrive at the cost of the roughing-in material:—as shown in

Fig. 1.—Bath room stack with supplies.

Fig. 2—Sink and laundry waste stack with supplies.

Fig. 3—Ice box waste stack.

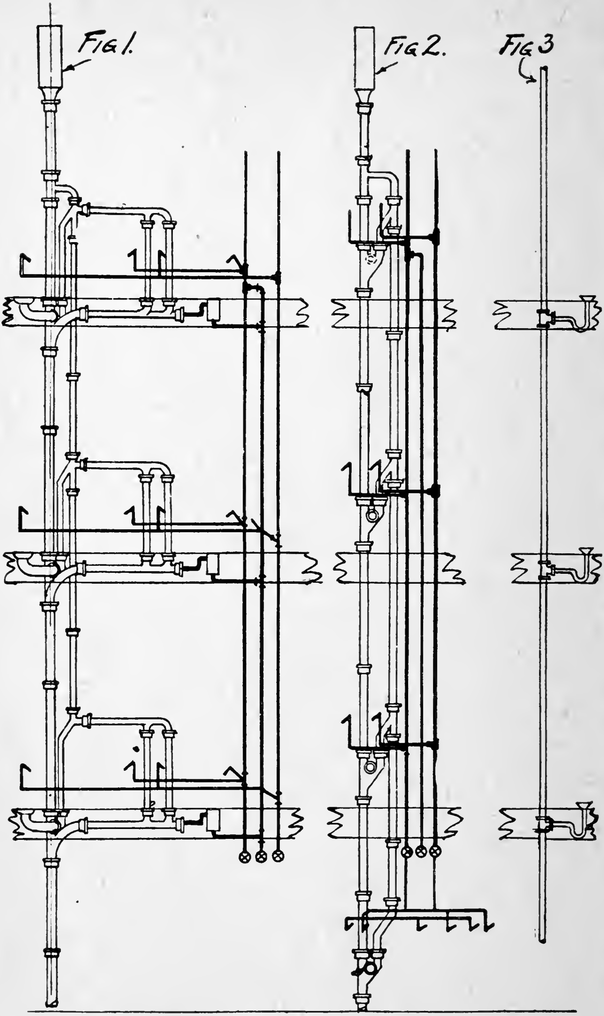
and this will apply to any kind of building.

Fig. 1 and 2 consist of all the 4″ and 2″ soil pipe, soil pipe fittings, branch waste and vent pipes, including supply pipes from basement sewer to roof plate. Fig. 3 consists of waste only.

Figure 1 on adjoining page shows a typical installation of a bath room stack in a three story Chicago apartment house. The soil fittings noted in Fig. 1 are known as Fruin and Walker or F. & W. fittings, listed and carried in stock by practically every jobber in plumbing supplies in the country. Regular soil pipe fittings can be used for such an installation at a slightly lower cost of material, but a much higher labor cost.

The pipe and fittings shown can be readily figured out by the estimator and cost of same ascertained from your wholesale dealer.

Once the cost of each stack is figured out much time is saved on succeeding jobs by merely checking off the number of stacks, which includes every-



ROUGHING-IN OF A 3 STORY FLAT BUILDING USING "F & W" FITTINGS.

thing required from roof to basement; then the basement supply pipe, including circulating pipes, the sewer pipe in basement, with floor drains, catch basins, conductor pipes, and connections to stacks. The outside water service to existing stub at curb or to City water main in street. The outside sewer pipe to City main or stub at curb. The fixtures such as bath tubs, water closets, lavatories, sinks, laundry trays, etc.

Labor costs under present conditions are somewhat of an uncertain quantity, and must be estimated for each individual job, the estimator having in mind the class of men he expects to put on the work, as it is a sad commentary, but nevertheless a fact, that plumbers today are less competent and efficient, more indifferent and careless, than, we will say, "before the war." This indifference or inefficiency makes the task of the estimator more difficult, but I have found that the following percentages on labor cost are fairly satisfactory in estimating labor:

Handling and setting fixtures—20% to 25% of fixture cost.

Installing roughing material—60% to 75% of cost.

The judgment of the estimator must be the guide, however, in considering the known difficulties that will have to be overcome in estimating labor costs.

In figuring galvanized piping for waste pipe, vent pipe, or water pipe, it is impossible to estimate every fitting required. I have found that from 65% to 75% of the pipe cost will cover the cost of all fittings required for the job, if pipe is measured carefully from plan.

Cast iron soil pipe fittings, including caulking lead and oakum, will run very close to 75% to 85% of pipe cost; judgment must be used, however, in considering the length of the pipe runs and the number of fixtures to be supplied. For instance, a run of pipe from a downspout stack would not require the per cent of fittings a bath room stack would call for.

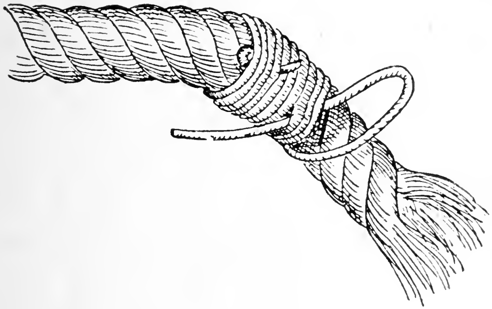
All Kinds of Knots and Bends Useful to Plumbers and Other Mechanics

Many plumbers, steam fitters, hoisting engineers, and other mechanics have asked me why I do not have an article in my book with illustrations on tying knots. Realizing that the knowledge of tying a reliable knot one that will not slip or loosen and one that can be easily untied, is of great value to almost all mechanics, I have added this subiect to my book.

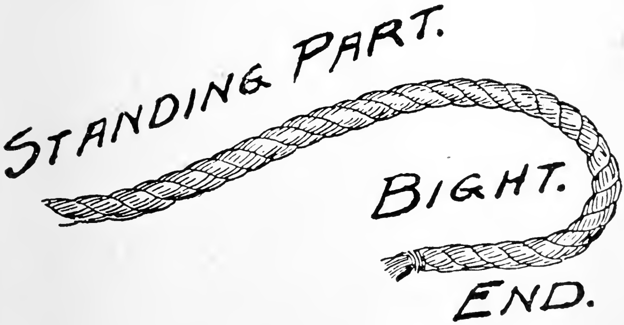
When handling and tying ropes the following terms are used: "Standing Part," "Bight" and "End." The "Standing Part" is the long part of the rope; the "Bight" is the curved part or loop, formed while working or handling; the "End" is that part used in forming the knot or hitch. Before commencing work, the loose ends or strands of a rope should be "whipped" or "seized" to prevent the rope from unraveling. An expert can tie a knot, make a splice, etc., without whipping, but we advise whipping the end before manipulating the rope.

To whip a rope, take a piece of twine or string, lay it on the rope an inch or two from the end, pass the twine several times around the rope, keeping the ends of the twine under the first few turns to hold it in place; then make a large loop with the free end; bring it back to the rope and continue winding for three or four turns around both the rope and end of twine; and finish by drawing the loop tight by pulling on the free end, as shown in Figure AA. Figure BB shows the "Standing Part," "Bight" and "End."

AA



BB



Nooses, Loops and Mooring Knots

On the following pages I give illustrations of a number of nooses, loops, mooring knots, and hitches, such as used by sailors. It always astonishes an onlooker (landsman) who is a careful observer, to see the easy manner in which a sailor handles heavy dripping hawsers or cables, and, with a few turns, makes them fast to pier-head or spile, so that although a tremendous pull is exerted, there is not the slightest give or slip to the rope. Yet, a moment later, with a few quick motions, the line is cast off, tightened up or paid out, as may be the case.

Figure "A" and Figure "B" show "Cleat" and "Wharf-Ties." A few turns under or over and around a cleat or two spiles is a method well understood and used by sailors.

Figures "C" and "D" show "Bow-Line on Bight" and "Running Bow-Line." The "Bow-Line on Bight," Figure "C," is easily made and is very useful in slinging casks and barrels and in forming a seat for men to be lowered or hoisted from buildings or ships when painting or cleaning.

Figure "D," the "Running Bow-Line," is merely a bow-line with the ends passed through the loop, forming a slip-knot.

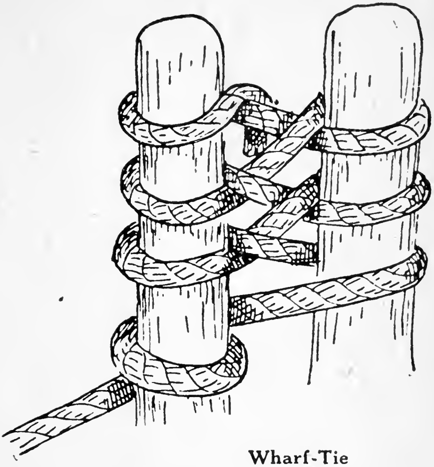
"Waterman's Knot," Figure "E," is often used, with a man holding the free end, for in this way a slight pull holds the knot fast, while a little slack gives the knot a chance to slip without giving away entirely and without exerting any appreciable pull on the man holding the end.

"Lark's Heads" are also used in conjunction with a running noose and is shown in Figure "F."

Fig. A

Cleat

Fig. B



Wharf-Tie

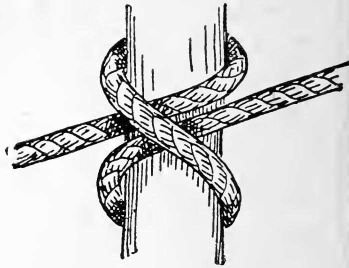
Fig. C

Bow-Line on Bight

Fig. D

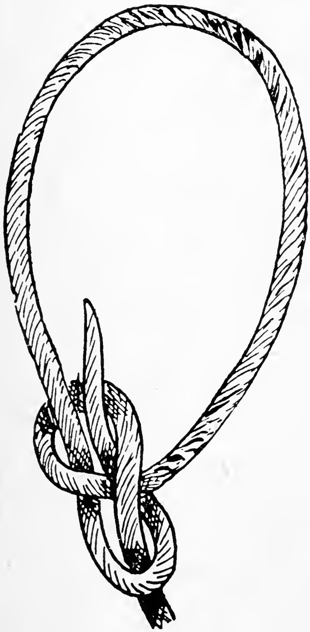
Running Bow-Line

Fig. E



Waterman's Knot.

Fig. G



Bow-Line

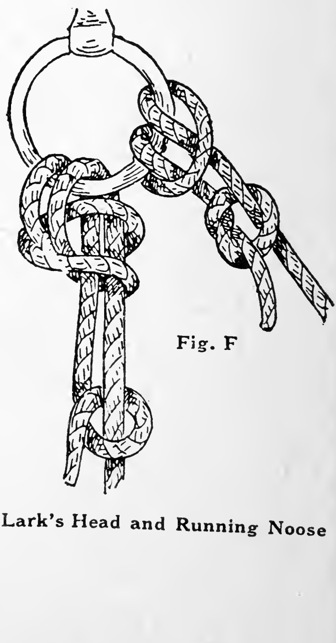
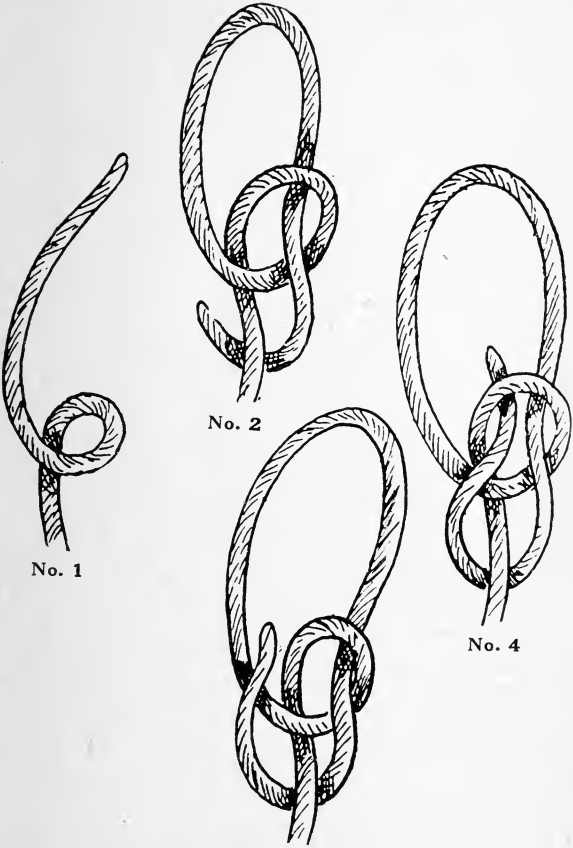


Fig. F

Lark's Head and Running Noose



No. 1

No. 2

No. 3

No. 4

Fig. G

The Bow-Line Knot

The Bow-Line Knot

(See Page 91)

The "Bow-Line" knot is by far the best knot and is used very much by sailors. It is a true knot, never slips, jams, or fails; is easily and quickly untied and is useful whenever a knot has to be tied. The knot completed is shown in Figure "G" No. 5 and in its various stages in No. 1, 2, 3 and 4. In No. 1 the rope is shown with a bight or cuckold's neck formed with the end over the standing part. Pass 1 back through the bight, under, then over, then under, as shown in 2, then over and down through the bight, as shown in 3 and 4, and draw taut, as in 5.

The Tomfool or Handcuff Knot, Etc.

(See Page 93)

Other loops are made, as shown in Figures "H," "I," "J" and "K," but they are not as safe and useful as the "Bow-Line," Figure "G."

Figure "L," known as the "Tomfool Knot," or "Handcuff Knot," is made like a running knot, Figure "H." The firm end is passed through the open, simple knot so as to form a double loop or bow. If the hands or wrists are placed within these loops and the latter drawn taut, and the loose ends tied firmly around the central part, a pair of secure handcuffs will be the result.

Lark's Head Knot

(See Page 94)

Knots used in securing a rope to an object are known as "hitches" or "ties." Figure "M" shows one of these, called "Lark's Head." To make this hitch, pass a bight of the rope through the ring, or other object to which you intend to hitch, and then pass a marline-spike, piece of round iron, pipe, or piece of wood, if you have nothing else at hand, as shown at "A." The end of the rope is then laid over and under the standing part and back over itself. This knot is instantly released by withdrawing the piece "A." Figure "N" shows the toggle with "A" withdrawn.

Fig. H

Fig. I

Fig. J

Fig. K

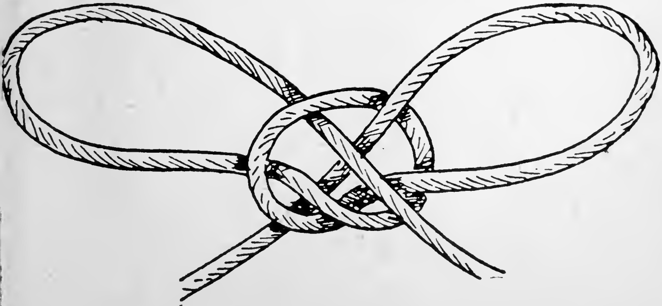


Fig. L

Fig. M

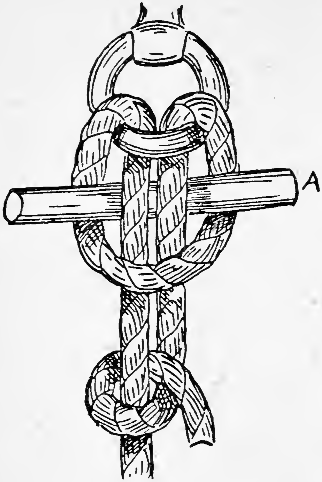


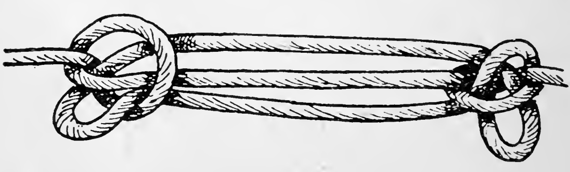
Fig. N

Lark's Head

Fig. R

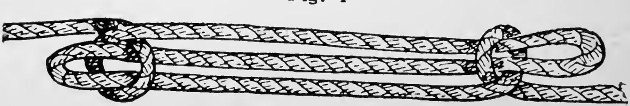
Bow Shortening

Fig. S



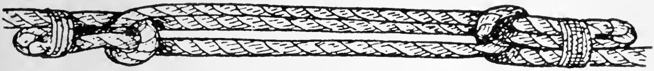
Sheepshank

Fig. T



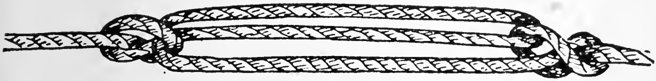
Another Sheepshank

Fig. U



Sheepshank with Ends Seized

Fig. V

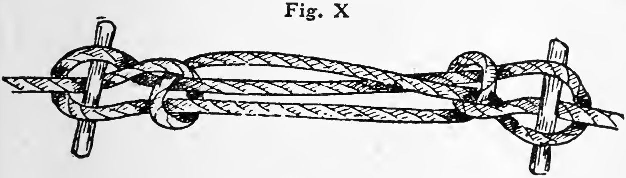


Sheepshank for Free-ended Rope

Fig. W

Sheepshank for Free-ended Rope

Fig. X



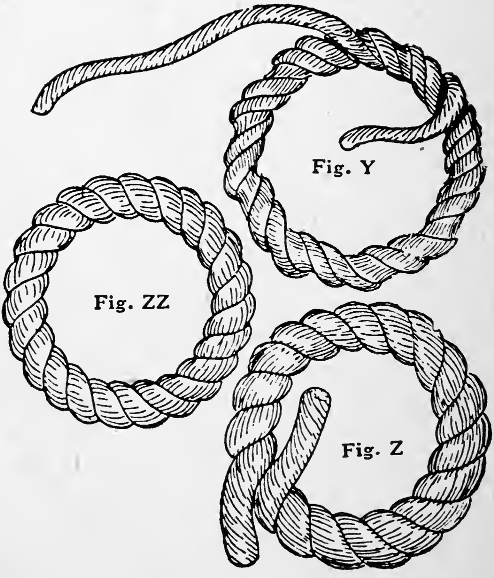
Sheepshank with Toggle

Figure "R" is a very simple shortening and needs no description. It will not withstand a very great strain, but is secure from untying by accident, and is very useful taking up spare rope of lashings on bundles or baggage.

"Sheepshank" or "Dogshank" are also used for shortening ropes, especially where both ends are fast, as they can be made in the center of the rope, although the rope is fast at both ends. The best and most secure form is shown in Figure "S." A

simple running knot is first made; a bend is pushed through the loop, which is then drawn taut; the other end of the bend is fastened in the same manner and the shortening is complete. A simpler forn is shown in Figure "T," but this can hardly be depended upon unless the ends are seized, as shown in Figure "U."

Figures "V" and "W" show two other kinds of shortenings, but these can only be used when ends of the rope are free, and are intended for more permanent fastenings than the ordinary Sheepshank. Figure "X" is particularly adapted to be cast loose at a moment's notice by jerking out the toggles.



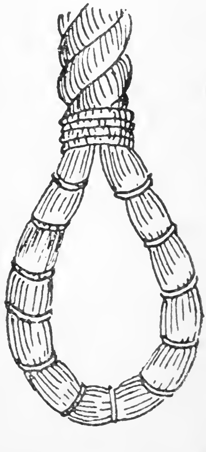
Grommets

Grommets are round, endless rings of rope, useful in many ways, often used as handles for chests, for rings to lengthen ropes, etc. A grommet is formed of a single strand of rope **five times as long as the circumference of the grommet when complete.** Take the strand and lay one end across the other at the size of loop required, and with the long end follow the "grooves" or "lay" of the strand until back to where you started, Figure "Y," thus forming a two stranded ring. Then continue twisting the free end between the turns already made until the three-stranded ring is complete, Figure "Z." Now finish and secure the ends by making overhead knots, pass the end under the nearest strand and trim off ends close, Figure "ZZ." If care is taken and you remember to keep a strong twist on the strand while "laying up" the grommet, the finished ring will be as firm and smooth and endless as the original rope.

Fig. BB

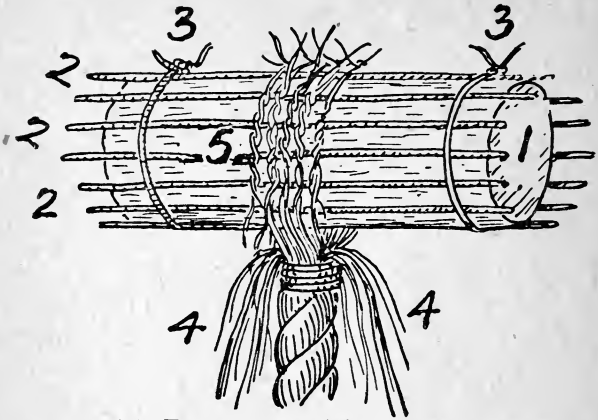
Artificial Eye

Fig. AA



Flemish Eye

Fig. AA1



A Flemish Eye, Figure AA, is an eye made in a manner as described below, and shown in process of making in cut, Figure AA1. Take a piece of wood, the size of the intended eye "1." Around this wood lay a number of pieces of yarn or marline, 2.2.2., and fasten them by tying with twine "3" and "3." Whip the piece of rope which eye is to be formed and unravel and open out the strand as at "4." Lap the yarn over the wood and the stops "5," and fasten together by overhand knots "5," worm the free ends under and over and then bring up the ends of the stops "2" and tie around the strands of eye, as shown. The eye may be finished neatly by whipping all around with yarn or marline, and will then appear as in Figure AA.

An artificial Eye, Figure BB, is still another form of eye, which will be found useful, and easier and quicker to make. It is also stronger. Take the ends of a rope and unlay one strand; place the two remaining strands back alongside of the standing part, Figure CC. Pass the loose strand, which has been unlaid, over the end, and follow around the spaces between the two strands and then around the eye,—as in making a grommet,—until it returns down the standing part and lies under the eye, with the strands, Figure DD. Then divide the strands, taper them down, and whip the whole with marline or yarn, Figure EE.

Another eye which at times is useful is the "Throat Seizing" shown in Figure FF. This is made by opening the end slightly and lashing it to the standing part, as shown.

Fig. CC

Fig. DD

Fig. EE

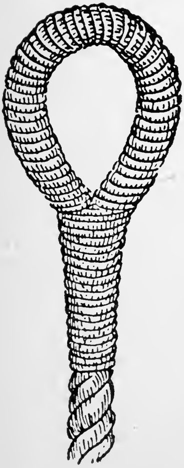
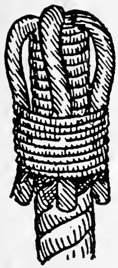


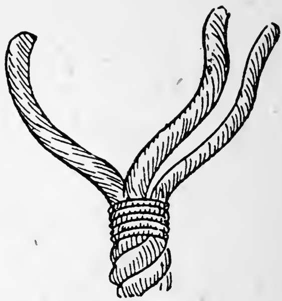
Fig. FF

Fig. GG



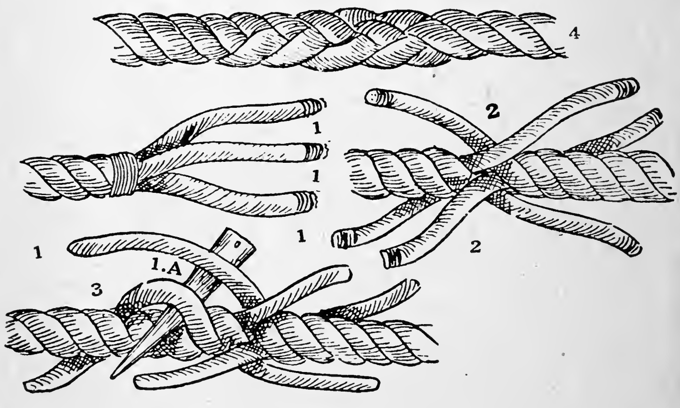
Ending Rope

Fig. HH



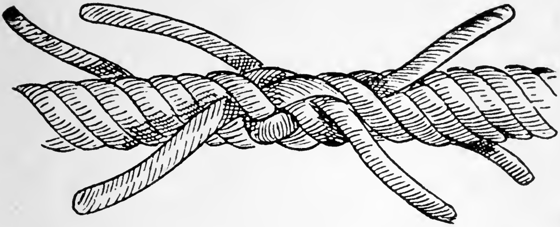
Ending Rope

Fig. II

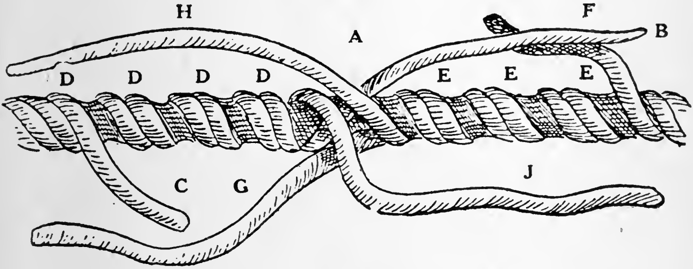


Short Splice

Fig. JJ



Short Splice



Long Splice
Fig. KK

A simple way of finishing the end of a rope is to seize the end, as shown in Figure GG, and open out the strands, bring the strands back alongside the rope, and whip the whole. (Figure HH).

Splicing is much better than tying or bending ropes together. A good splice always looks better than a knot. A man familiar with splicing will make a splice almost as quickly as the ordinary man can tie a secure knot. In many cases where a rope must pass through sheaves or blocks a splice is absolutely necessary to fasten the ends of two ropes or two parts of parted rope together.

The simplest of all splices is called the "Short Splice," Figure II. This is made as follows: Untwist the ends of rope for a few inches and seize with twine to prevent any more unwinding, as shown; also seize the end of each strand to prevent unraveling and grease or wax the ends until

smooth and even. Now place the two ends of the ropes together, as shown, Figure JJ. Then with a marlin spike, or pointed stick, work open the strand, 1.A, and through this pass the strand No. 1 of the other rope; then open strand No. 3 and pass the next strand of the other rope through it, and then the same way with the third strand. Next, open the strands of the other rope, below the seizing, and pass the strands of the first rope through as before, No. 1 and No. 2. The ropes will now appear as in No. 4. Now untwist the six strands and cut away about half of the yarns from each and seize the ends as before. Pass these reduced strands through under the whole strands of the rope,—the strands of the left under the strands of the right rope, and vice versa,—for two or three lays, and then cut off projecting ends, after drawing all as tight as possible.

If an extra neat splice is desired, the strands should be gradually tapered as you proceed, and in this way a splice but little larger than the original size of the rope will result. The only difficulty that may be found in making this splice is in getting the strands to come together in such a way that two strands will not run under the same strand of the opposite rope. To avoid this, remember that the FIRST STRAND MUST BE PASSED OVER THE STRAND WHICH IS FIRST NEXT TO IT AND THROUGH UNDER THE SECOND AND OUT BETWEEN THE SECOND AND THIRD. In the following operations the strands are passed OVER the third and UNDER the fourth; the figures will make this clear.

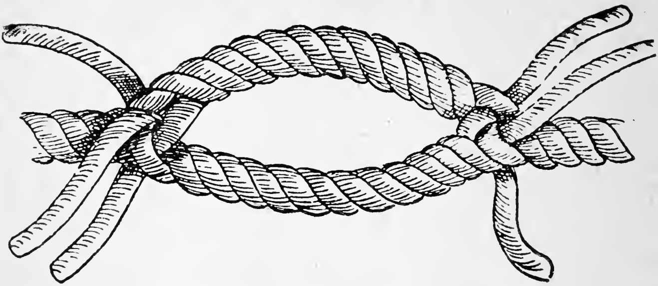
A very much better and stronger splice is the "Long Splice," which will run through any block that will admit the rope itself. A well-made long splice can not be noticed on the rope after a few days use. To make this splice, unlay the ends of the rope about four or five times as much as for short splice, or from four to five feet; unlay one strand in each rope half as much again; place the middle strands together as at A. Then the additional strands will appear as at B and C, and the spiral groove, left where they were unlaid, will appear as at D and E. Take off the two central strands, F and G, and lay them into grooves D and

E, until they meet at B and C; and be sure to keep them tightly twisted. Then take strands H and J, cut out half the yarn in each, make an overhand knot in them, and tuck the ends under the next lays as in short splice. Do the same with strands B and C and F. and G, dividing, knotting and sticking the divided strands in the same way. Finally, stretch the rope tight, pull and pound and roll the splice until smooth and trim off all loose ends close to the rope.

Fig. LL

An "Eye Splice," Figure LL, is easy to make and is useful in many ways. It is made in the same way as a short splice, but instead of splicing the two ends together, the end of the rope is unlaid and then bent around and spliced into its own strands of the standing part, as shown in the illustration.

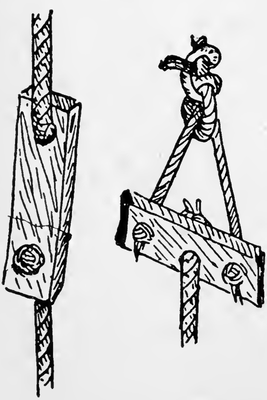
Fig. MM



A "Cut Splice," Figure MM, is made just as eye splice or short splice is made, but instead of splicing two ropes together, end to end, or splicing an end into a standing part, the ends are lapped and each is spliced into the standing part of the other, thus forming a loop or eye in the center of the rope.

Fig. NN

Fig. OO



When a person has acquired the knowledge of making knots, ties, bends, hitches, and splices, he will find the usefulness of ropes in many ways. Barrels, casks, bales, timbers, bundles of pipes, and other objects can be securely roped or slung. A buckle may be formed as shown in Figure NN. If a swivel is required it can be arranged as shown in Figure OO. Several simple slings are shown in Figure PP.

Fig. PP

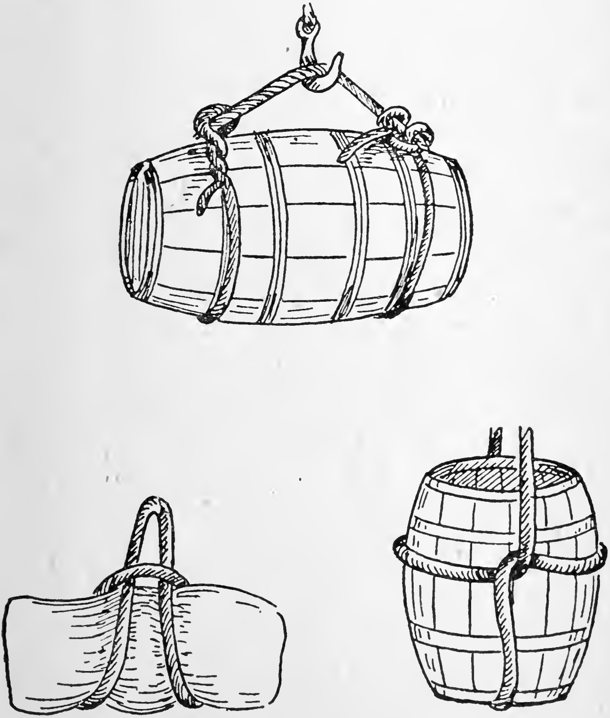


Fig. RR

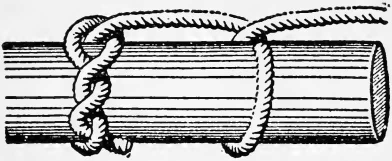
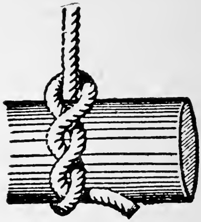


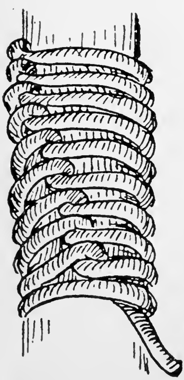
Fig. SS

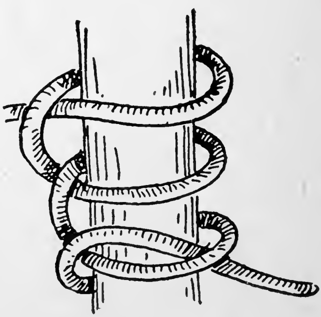


These Hitches are Handy for a Mechanic

Figure RR is called "Timber Hitch" and Figure SS is a "Timber and Half Hitch." Both are much used by sailors and mechanics, such as plumbers, steam fitters and gas fitters, when hoisting pipes and other materials. If, however, pipes and other materials or fixtures are required to be hoisted in a horizontal position, the "sling" is best.

Fig. QQ





Half Hitchwork

To prevent a rope from unraveling at the ends, the ends are treated in several ways. Half hitchwork, as shown in Figure QQ, is a very simple way and is often used for doing this, and is done as follows: Take a half hitch around the rope to be served, then another below it; draw tight; take another half hitch, and so on until the object is served and a series of half hitch knots form a special twist, as shown in illustrations.

There are endless occasions where the half hitch knot can be used. Ropes, a spliced piece of wood such as a hammer handle, bottles, jugs, and many other articles can be covered with half hitch knots.